FEBRUARY • 1956

PETROLEUM REFINER

REFINING | PETROCHEMICALS | NATURAL GASOLINE

© Gulf Publishing Co.

- *Special Report . . .* Operations Research Today Page 100
- Fibers to Watch Page 109
- Motor Starting Problems Page 117

The 72-ton top section of a reactor-regenerator, fabricated at CB&I's Birmingham plant, swings through the air during erection.

Such structures are the result of Chicago Bridge & Iron Company's vast experience and complete facilities *so necessary* to engineer, fabricate and erect refinery structures to exacting specifications. Write our nearest office for further information.

CB&I

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

REPRESENTATIVES AND LICENSEES:
Brazil • Canada • England • France • Italy • Netherlands • Scotland • Venezuela

PROVED BY PERFORMANCE OF *OVER A MILLION* TRAPS!

YARWAY IMPULSE STEAM TRAP

the only moving part

... a small stainless steel valve that literally floats on the condensate load. Gets equipment *hot in a hurry*—and *keeps it hot!*

Using a theory of thermodynamics never before applied to steam traps, the YARWAY Impulse Trap revolutionized the industry *20 years ago*. Today over a million YARWAY traps have successfully proved the Impulse principle.

Advantages like the following continue to win new users, convince old users to standardize:

- **QUICK HEAT-UP AND EVEN TEMPERATURES OF EQUIPMENT**
- **GOOD FOR ALL PRESSURES WITHOUT CHANGE OF VALVE OR SEAT**
- **SMALL SIZE—LIGHT WEIGHT**
- **ONLY ONE MOVING PART**
- **STAINLESS STEEL—minimum maintenance**
- **WON'T FREEZE UP**
- **A COMPLETE LINE of sizes and types for every requirement**
- **IMMEDIATELY AVAILABLE from 270 local Industrial Distributors**

For free Trap Selector, or 24 page bulletin, write
YARNALL-WARING COMPANY 128 Mermaid Avenue, Philadelphia 18, Pa.

THERE'S A YARWAY IMPULSE STEAM TRAP FOR EVERY NEED

SERIES 60 and 120
For all *normal* trap requirements, pressures to 400 and 600 psi.

½" No. 20-A
For *light loads* on tracer lines, steam mains, small presses, etc.

SERIES 40
For *heavy loads* requiring extra high capacity steam traps

INTEGRAL-STRAINER HIGH PRESSURE TRAP
For *high pressures, high temperatures.* (Flanged or welding connections.)

YARWAY

IMPULSE® STEAM TRAP

OVER 1,000,000 YARWAY IMPULSE STEAM TRAPS USED

Volume 35, No. 2 February, 1956

PETROLEUM
REFINER
REFINING | PETROCHEMICALS | NATURAL GASOLINE

NEW MANAGEMENT TOOL

This Is Operations Research 100
Merrill M. Flood
Refining Can Use Operations Research 103
Arthur A. Brown
How Reliable Are Lab Analyses? 106
John T. Walter

OTHER TECHNICAL FEATURES

Petrochemicals in Synthetic Fibers 109
Thomas C. Ponder and J. J. McKetta
Snap-On Insulation 112
There's a Limit to Use of Equations of State 113
Lawrence N. Canjar
Know Your Motor Starting Problems 117
Lee B. Eddy
Nomograms . . . Make Your Own (Part 3) ... 121
Francis W. Winn
New Way to Clean Up Fuels 125
P. J. McGuire and H. A. Price
Gas Absorption Calculations 127
S. R. M. Ellis
Taking Stock 132
Cecil W. Smith.
Gas Conditioning Today (Part 2) 133
A. L. Kohl and F. C. Riesenfeld
How Effective Is Your Maintenance Dollar? (Part 2) 135
A. N. Smith
Sulfur Compounds from Petroleum 138
Lewis F. Hatch
Union Flares Blowdown Without Smoke 143
J. R. Hannaman and A. J. Etingen
Licensing Your Process 147
Robert S. Aries
Continuous Vacuum Rotary Filters 149
C. D. Holland and J. F. Woodham
Refining Forecast: $20.1 Billion Outlay by 1965 .. 152
New Method for Pipe Stresses (Part 3) 153
K. Hao Hsiao
New Tests on Castables 158
C. M. Vogrin and Heinrich Heep

As Management Sees It

Socony Mobil's Greatest Expansion Period 98
'Blueprint' for Retirement 202
Mold Your Own Leaders 205
W. L. Linton
Showmanship Can Prevent Accidents 212
Paul Lockwood

DEPARTMENTS

Quick Look 4
Mail Box 86
Quick Look at Industry ... 89
Look Box 93
Valuable Reading Ahead 164
How to Do It 166
Reviewing New Books ... 172
Heard at Meetings 178
Meetings Calendar 182
Who's Building 187
What's Happening 217
Men in Industry 230
Suppliers Notes 236
Classified Advertising ... 254
New Equipment 258
New Literature 271
Index to Advertisers 272
Readers' Service Card ... 273

A Quick Look
at This Issue

These handy digests permit checking those articles you want to read first.

NEW MANAGEMENT TOOL

☐ **This Is Operations Research** . . . Many of the techniques used in OR are old, but their application to business and industrial management is new. Read how OR brings into focus many industrial functions by the use of mathematical models. Turn to Page 100.

☐ **Refining Can Use Operations Research** . . . Whether determining the optimum storage capacity or establishing the refining required for a certain crude, Operations Research will help you. For a new technique that is fast catching on in progressive companies, turn to Page 103.

☐ **How Reliable Are Lab Analysis?** . . . Better control of an operation requires better information concerning the products of that operation. Statistics may be used to show the relation of analytical and process variations to product quality. Control charts are used to keep a record of these variations. Page 106.

☐ **Petrochemicals in Synthetic Fibers** . . . The amazing way in which these man-made fibers have been accepted assures their continued growth. There is great potential in this phase of the petrochemical industry. For a complete description of this fast-growing industry, turn to Page 109.

☐ **There's a Limit to Use of the Equations of State** . . . and you'd better be careful or you may find yourself beyond the region of application. Here is a discussion of the various methods of defining complex systems and the limits of each. You'll use this warning signal each time you plan to work with vapor-liquid equilibria. Put this one in your thermodynamics notebook. Page 113.

→ Now Turn the Page →

A Quick Look at This Issue

☐ **Know Your Motor Starting Problems** . . . Here is a thorough review of the kind of problems you may run into. The rapid increase in the use of electrical drives makes this must reading for all. Keep yourself up to date by turning to **Page 117.**

☐ **Nomograms . . . Make Your Own** . . . Can you make nomograms for different types of equations or relations? If the answer is "no" and you would like to learn how to make nomograms—the easy way, turn to **Page 121.**

☐ **New Way to Clean Up Fuels** . . . This is a progress report on a design for fuel clean-up. Water scrubbing, coalescing, filtering, and salt drying are combined in one unit to remove wax, dirt, and water from fuels. Turn to **Page 125.**

☐ **Gas Absorption Calculations** . . . Here's a short way to make your calculations on absorption and stripping problems. This method takes into consideration the varying gas-oil ratios and can also be applied to multicomponent problems. Three sample problems are solved for you this easy way. This is for your work book. See **Page 127.**

☐ **Gas Conditioning Today**—It's time to take a look at what's happening in this field—what the problems are and how they're being solved. You'll find no better summation than what these experts have to say about the field. The second part of this series will bring you up-to-date on dehydration. Turn to **Page 133.**

☐ **How Effective Is Your Maintenance Dollar?** . . . Part 2 gives you a complete insight to the application of work sampling as a means of evaluating your maintenance force activity. And you get the details of how to analyze your findings. This method can be used for about one fourth the cost of a conventional time study, yet you get the same results. Turn to **Page 135.**

☐ **Sulfur Compounds From Petroleum** . . . Here is a complete description of the various types of sulfur compounds—sulfides, di-sulfides, sulfones and mercaptans. The method of synthesis and utilization of sulfur compounds is discussed. For complete details turn to **Page 138.**

☐ **Union Flares Blowdown Without Smoke** . . . Could you use a modern relief system in your refinery? Here is the story of the mechanical design and arrangement of a new system. The operation, both at design and under emergency conditions, is described and also the actual equipment used. You can start planning now by turning to **Page 143.**

☐ **Licensing Your Process** . . . Got a good process? Think it's worth licensing? Would you like to license it to some company in a foreign country? If you answered YES to all of these questions and would like to know what to do, what to avoid and how to assure yourself of maximum profits, turn to **Page 147.**

☐ **Continuous Vacuum Rotary Filters** . . . Suppose you change the speed of rotation of your filter, or the depth of submergence, or increase the pressure drop, or make other operational changes. What corresponding filtrate rate should you expect? This article gives you an exact mathematical treatment of rotary filters. The answers to the above questions are easily and accurately determined by the simple manipulations suggested on **Page 149.**

☐ **$20.1 Billion Outlay by 1965** . . . This is Chase Manhattan Bank's prediction of the amount refiners will spend to meet sky-rocketing demand. For complete statistics on the predicted phenomenal growth of refining in the next 10 years, turn to **Page 152.**

☐ **New Method for Pipe Stresses** . . . You'll find this method a big time-saver in computing stresses in a three-dimensional piping system, as well as making the whole procedure much simpler. This third and last part in the series shows you how to handle elbows and bends in such systems. Check the October, 1955, issue if you missed the basic approach in this tabular method. Turn to **Page 153.**

☐ **New Tests on Castables** . . . The application of insulating and refractory castables in petroleum industry plants continues to increase. You will need to know just how these materials can be expected to perform and what certain service conditions can do. Here is up to the minute test data that answers many questions about castables that you have possibly asked. Turn to **Page 158.**

☐ **Socony Mobil's Greatest Expansion** . . . 1946 to 1955 saw this company increase its crude capacity from 400,000 to 670,000 barrels a day. For the story of ten years of refinery construction, see **Page 98.**

☐ **'Blueprint' for Retirement** . . . Do you have any definite plans for retirement? How will you pay for it? Shell organizations have started a thought-provoking Planning for Retirement program that already is showing excellent results. **Page 202.**

☐ **Mold Your Own Leaders** . . . Use of the group in making top management decisions is firmly established in modern industry. However, few companies have a program tailored to foster this trend. On **Page 205** is a plan that will help you train industrial management groups.

☐ **Showmanship Can Prevent Accidents** . . . Seeking new ways to make your employes safety conscious? Then turn to **Page 212** for a select group of safety projects designed to inject new life into your safety program.

PETROLEUM REFINER

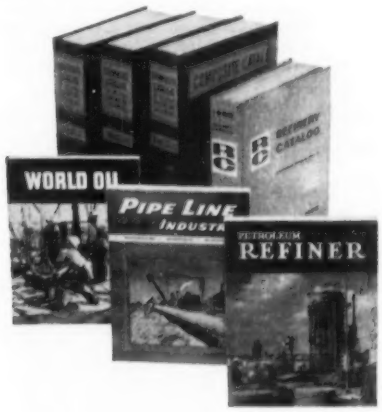
RAY L. DUDLEY.....Publisher
TOM W. NELSON.....General Manager
R. M. DE SOMBRE.....Assistant General Manager
SILAS B. RAGSDALE.....Editorial Director
DR. JOHN J. MCKETTA, JR.....Chairman of Editorial Committee
GEORGE B. GIBBS.....Editor
PAUL E. NICHOLLS, JR.....Maintenance and Design Editor
HAROLD L. HOFFMAN.....Process and Construction Editor
THOMAS C. PONDER.....Petrochemicals Editor
DON E. LAMBERT.....Management and Personnel Editor
CECIL W. SMITH.....Economics Editor
HARRISON T. BRUNDAGE.....Eastern Editor
GILBERT M. WILSON.....Western Editor
DR. LEWIS F. HATCH.....Contributing Editor
WALLACE FITZGERALD.....Managing Editor
BILLINGS D. BARNARD.....Editorial Assistant
JACK COCKERHAM.....Presentation Editor
EUNICE OKONESKI.....Librarian

ADVERTISING

HOUSTON (19): Tom W. Nelson, Jack Walker, Charles Wyatt, Wm. G. Dudley, 3301 Buffalo Drive, Phone JAckson 9-4301; NEW YORK (17): Gene Hart, George Skelton, Nelson Bigelow, 250 Park Ave., Phone El Dorado 5-4012; CLEVELAND (15): Harvey Dunn, Bill Westfall, 1010 Euclid Ave., Phone MAin 1-3295; CHICAGO (4): Martin Halloran, H. G. Fitzpatrick, 332 S. Michigan Ave., Phone Wabash 2-9330; LOS ANGELES: Jay Curts, W. W. Wilson Bldg., Huntington Park, Phone Ludlow 7-1219; TULSA (3): Jim Isaacks, Hunt Bldg., Phone 3-1844; DALLAS (2): Ed Thompson, 518 Second Unit Santa Fe Bldg., Phone PRospect 7344. EUROPEAN: Theodor Miocha, Agent, Limmerstrasse 31, Hannover, Germany, Phone 42935. UNITED KINGDOM: Frank Chambers, Agent, 120 Moorgate, London E.C.2, Phone Monarch 5661. Advertising rates on application. Cable address: GULFPUBCO, Houston.

SUBSCRIPTIONS

R. M. de Sombre, Circulation Manager, P. O. Box 2608, Houston 1, Texas, U.S.A. Single copies 50 cents (except special issues) for U. S. and Canada; $1 for all other countries. Subscription rates—U. S. and Canada $2 a year; Latin America and overseas $5 a year. Subscriptions restricted to those engaged in refining, natural gasoline or petrochemical industries or service and supply company personnel connected thereto. PETROLEUM REFINER, published on the 13th of every month, entered as second class matter June 16, 1923, at the post office at Houston, Texas, under act March 3, 1879. Copyright 1956 by The Gulf Publishing Company.



Specialized Oil Publication of
THE GULF PUBLISHING COMPANY
Box 2608, Houston (1), Texas

PETROLEUM REFINER and The REFINERY CATALOG for the refining natural gasoline-petrochemical industry

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry

PIPE LINE INDUSTRY for the oil and gas pipe line industry

Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, An Arbor, Michigan.

Note RC's New Face

NOTICE THAT NEW FACE for the *Refinery Catalog* pictured with its publication brothers and sisters alongside? We are all quite proud of this new look and the reception it's getting as the 23rd edition, now off the press, is reaching the desks of its thousands of users. But better than the new cover design is the content of the book itself. It is more complete, more useful than ever before. Certainly it's the best single source of data on equipment, materials and services for the refining, natural gasoline, and petrochemical industry. If you hold a buying power job and your name has not been submitted to us by your company, tell your immediate supervisor that you'd like to be included. We're most anxious for all in position to buy or specify to have their copies of RC.

Easy Clipping Here

EVER ASK YOUR SECRETARY which technical magazine is the easiest to clip? She'll probably tell you PETROLEUM REFINER, because of the attention we give to making our articles clippable. If you clip the magazine yourself, you've probably noted that unless the article is integral to a symposium, you are able to remove it without any conflicts with other feature articles.

We've been doing this for a number of years and judging from our spring survey, you readers really like it. We found out in this survey that 35 percent of you regularly clip articles.

Even more flattering to us was that 97 percent of our readers clip or save copies. This survey showed that 35 percent save the entire issue, 11 percent save the entire technical section, 17.5 pass it along, while only 3 percent discard the entire issue.

A New Tool

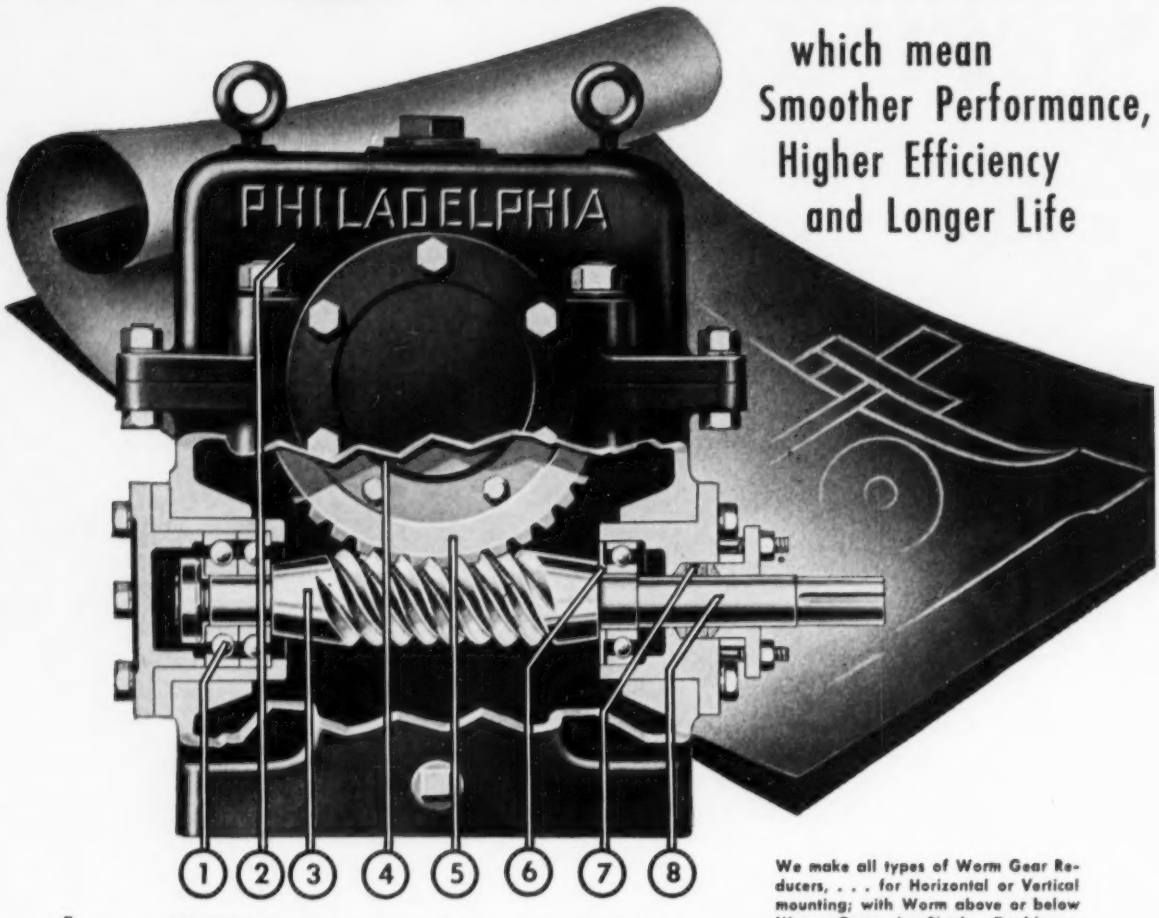
With the growing complexity of our industry, the amount of information needed by a wise management increases. The question seldom is whether we know what information is required, but rather whether we have the time and methods to weigh and properly evaluate this information. Now some old techniques, and a few new ones, are being brought together to form a new science called *Operations Research*. This concept places in the hands of management more data than was possible heretofore. Information is resolved into the language of numbers and then fed to high-speed calculators. Aspects of *Operations Research* are presented in a special report in this issue. You will want to turn to Page 100.

Here's a Ditto

Here's repetition: There are available, for the asking, (1) PETROLEUM REFINER's revised Author's Handbook and (2) the Annual Index of PR's Editorial Content. For either or both just address the Editorial Department, PETROLEUM REFINER, Box 2608, Houston 1, Texas.

YOU GET ALL THESE ADVANTAGES...

which mean Smoother Performance, Higher Efficiency and Longer Life



1____ **BEARINGS** throughout are of highest quality, calculated to take all loads and stresses in accordance with maximum ratings of units.

2____ **EXCEPTIONALLY RIGID HOUSING** of best grade cast iron . . . Strengthening ribs integral with design.

3____ **WORMS** made of SAE 3115 Steel with carburized and hardened threads. Shaft and threads smoothly ground after hardening.

4____ **GEAR SHAFT BEARINGS** run in an oil well that automatically fills with fresh oil when filled from top. Splash from the gear keeps the wells filled to the overflow point.

5____ **WORM GEAR** made from quality chill cast nickel bronze bolted to a semi-steel center. (Smaller sizes are solid bronze.)

6____ **WORM AND WORM BEARINGS** run in oil bath. Baffle plates prevent flooding.

7____ **WORM SHAFT** equipped with stuffing box to prevent oil leakage.

8____ **SHAFTS** are premium quality. Always accurate, straight, concentric.

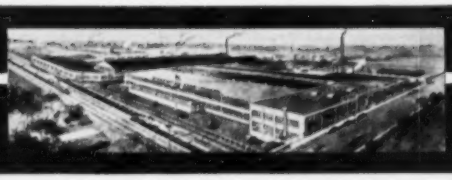
We make all types of Worm Gear Reducers, . . . for Horizontal or Vertical mounting; with Worm above or below Worm Gear; in Single, Double or Triple Reductions for medium or heavy duty service; any horsepower or reduction ratio.

Tell us your Speed Reduction problems, and a Philadelphia Sales Engineer will gladly call upon you, . . . without obligation.

Catalog WG-51 sent upon request on your letterhead.

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.
BALTIMORE • CLEVELAND
Virginia Gear & Machine Corp. • Lynchburg, Va.



Industrial Gears & Speed Reducers

LimiTorque Valve Controls

Established 1892

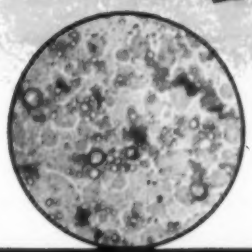
For more data on advertised products, use Readers' Service Cards, last page.

Visco Laboratory Reports

TAKE THE RISK OUT OF DESALTING TREATMENTS

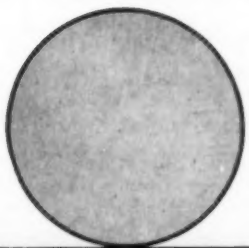
No one knows better than you the dollar loss from a poor desalting set-up.

And you know, too, there's no such thing as a blanket cure-all. But a Visco Laboratory Report *does* point the way to the results you want — from every type of crude — at no added cost to you.



Photomicrograph—
Emulsified refinery crude

In a typical case, 20 or more separate desalting compounds and laboratory formulas may be checked and all contributing factors will be considered before the final desalting recommendation is made.



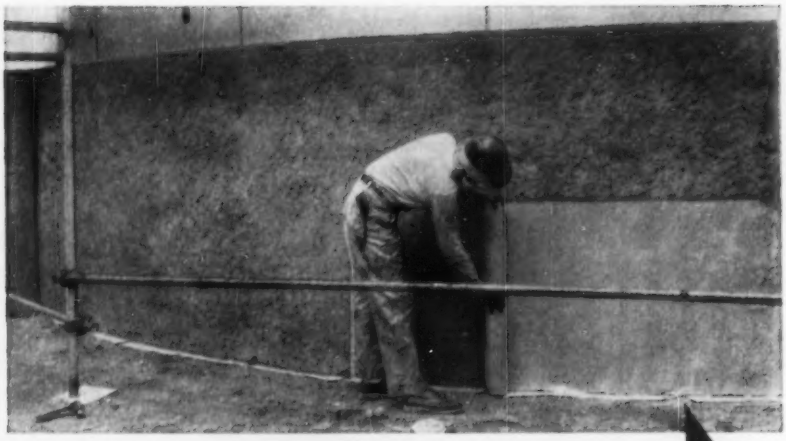
Photomicrograph—Emulsified refinery crude after Visco desalting

If you would like our desalting recommendation for your crude, send Visco a five-gallon can of the crude and one gallon of the water used in your refinery desalting. Or better yet, check with your Visco representative, and he will arrange for these services.

VISCO PRODUCTS COMPANY
INCORPORATED
2600 Nottingham at Kirby • Houston 5, Texas • Telephone: MAdison 3-0433

Visco® CONSISTENTLY EFFICIENT OIL INDUSTRY CHEMICALS

SOME RUN IT UP AND DOWN



SOME RUN IT ROUND AND ROUND...

VERSATILE

ULTRALITE

TANK INSULATION

Techniques of applying Ultralite vary, but everyone agrees that it is by far the fastest and cheapest way to insulate tanks, vats, vessels and other heated equipment.

With blanket rolls up to 10 feet wide, in no time at all you can cover any regular or irregular shaped vessel with this flexible glass fiber insulation. What's more, the vessel will be insulated "once and for all" — for Ultralite is a permanent insulation.

When you consider that labor is by far the big item in insulating, it makes sense to select the insulating material that lends itself to the fastest, easiest application. That material is Ultralite, the only insulation of long textile-type glass fibers. Write today for samples, prices, specifications and suggested application methods.

GUSTIN-BACON *Manufacturing Company* GUSTIN gb BACON

Thermal and acoustical glass fiber insulations • Pipe coverings and fittings • Molded glass fiber pipe insulation

242 W. 10th St., Kansas City, Mo.

There's **MORE** Cooling Surface in these deep-ribbed **MOTORS**

No Day is FRYDAY

with these Allis-Chalmers MOTORS

● Frying of insulation is impossible under normal conditions with the extra-large cooling surface of Allis-Chalmers rib-type TEFC motors. The result—you expect and get longer motor life.

The engineered partner of A-C motors is Allis-Chalmers control.

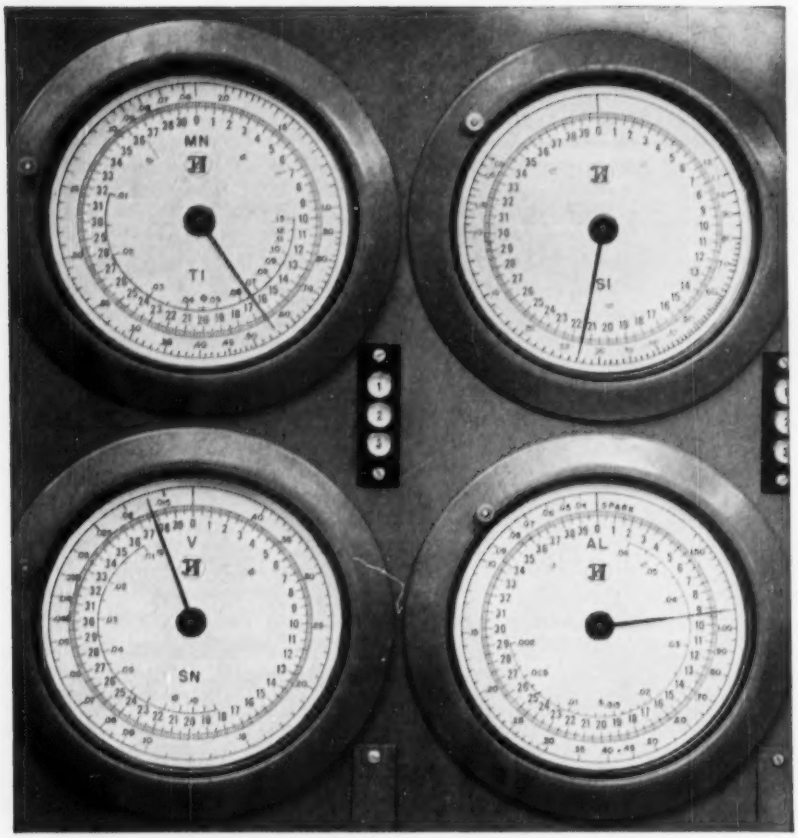
Get Complete Information

As a new machinery component or as replacement, specify Allis-Chalmers. Discuss your particular application with your nearby A-C distributor, A-C district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-4853



We see what's in TIMKEN® steel while we make it, to give you greater uniformity in your forgings

YOU see above four of the twelve spectrometer dials used to analyze steels being melted at the Timken Company. In just 40 seconds this direct-reading spectrometer tells the exact chemical composition of a heat of Timken fine alloy steel. Results are flashed back to the furnace so the melter can keep close control of the analysis. This carefully controlled chemistry produces uniform composition from heat to heat. You can be sure that forgings made from Timken® forging steels will give you uniformly high ductility and resistance to impact.

And because your order of Timken forging steel is handled individually in our mill we are able to target our conditioning procedure on your particular forging requirements. This minimizes your rejects.

Here's an added plus: Timken steel forging bars *save* you steel because their good dimensional tolerances produce uniform weight multiples with a minimum of steel lost in flashings. Get all these results in your forging steels. Specify Timken forging steels. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

What is your Control Need?

. . . a starter for a fractional hp motor?

This small inexpensive control provides thermal overload protection. . . . Compact construction permits mounting where space is at a premium. Designed for use on ac single-phase power systems . . . up to 230 volts.

. . . a controller for a 2300 to 5000-volt motor?

Here is a control for motors up to 2500 horsepower. All components — contactors, meters, overload relays, auxiliary switches — are selected to meet the particular requirements of your application. Current-limiting fuses give split cycle short circuit protection.

. . . or other applications?

Specific applications, including those between the above-mentioned limits, are made from an extensive line of starters and control components. These standard units are factory assembled in infinite combinations to meet practically any requirement. For help on a particular application, call your Allis-Chalmers representative. His recommendations are backed by Allis-Chalmers engineering departments . . . by experience gained solving thousands of control problems . . . by complete research and testing facilities.

A-4721

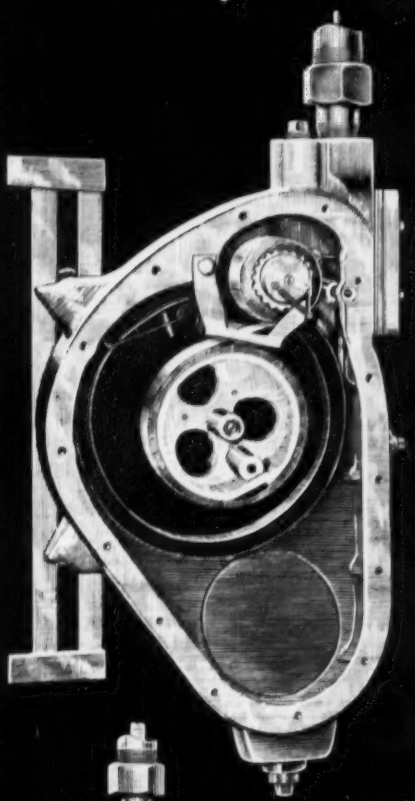
A-C ALLIS-CHALMERS

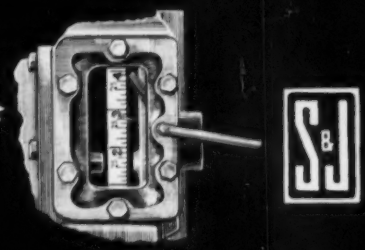
ALLIS-CHALMERS

Milwaukee 1, Wisconsin

For more data on advertised products, use Readers' Service Cards, last page.

Anticipating YOUR NEED—





Anticipating the day when you may wish to convert all of your direct ground reading automatic tank gages to a remote reading system, S. & J. announces the new ST-8000 Automatic Tank Gage, designed with a gage head that will provide you with direct ground reading measurements TODAY, and will accommodate the necessary remote reading transmitter sprocket integrally. This will eliminate the purchase of a sprocket housing, and the nuisance and expense of its installation when the day comes that you wish to put remote gaging into effect. It enables you to enjoy all of the advantages of automatic tank gaging, with readings taken at each tank NOW, and makes it easier and less expensive when you decide to speed up with remote reading gages.

The S. & J. ST-8000 Automatic Tank Gage is the last word in tank gage development. It incorporates a Neg'ator motor to eliminate the counterweight and cable assembly, and provides constant tape tension throughout float travel, assuring maximum accuracy at all liquid levels. This gage will serve tanks to 65' in height, and with materially reduced bearing loads, will provide a minimum fatigue life of 13,000 cycles, equal to up and down twice a day for nearly 20 years. For complete information of the ST-8000 Automatic Tank Gage, write the factory or the nearest branch listed below.

Shand and Jurs Co.
BERKELEY 10, CALIFORNIA

NEW YORK
342 Madison Ave.

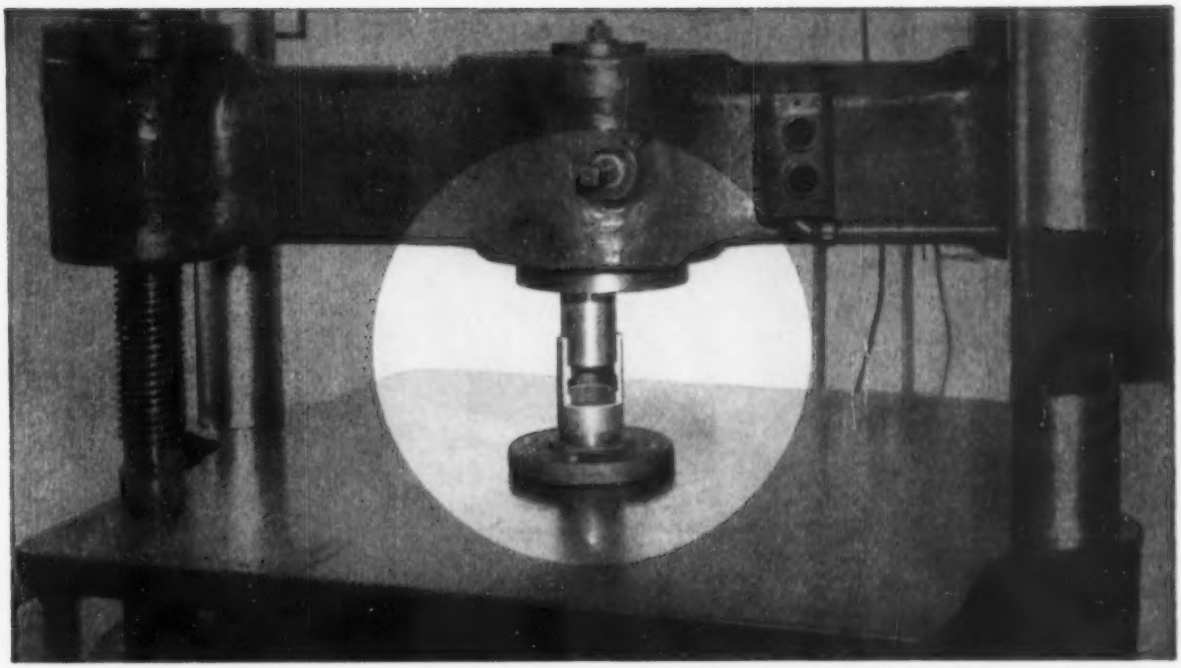
HOUSTON
M & M Bldg.

TULSA
Thompson Bldg.

CHICAGO
10409 S. Western Ave.

LOS ANGELES
6399 Wilshire Blvd.

REPRESENTATIVES:
SEATTLE: Nebar Supply Company, 3000 Western Avenue
MONTREAL: Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W.
TORONTO: Lytle Engineering Specialties, Ltd., 69 Eglington East
VANCOUVER: P. D. McLaren & Son, Ltd., 3277 Main Street
CARACAS: Sinclair Spence, C.A., Edificio Galipan
ENGLAND: Whessoe, Ltd., Sales: 25 Victoria St., London S. W. 1
Whessoe, Ltd., Works: Darlington, County Durham



Bond holds despite shear exerted by mandrel on lead lining in test section of "Tubond" pipe.

Now...in "Tubond" pipe...a bond stronger than the tensile strength of lead

National Lead's improved bonding process inseparably weds lead to steel

Squeeze it, abuse it . . . no breaks appear in the casing, lining, or bond.

Twisted once, twisted twice . . . the second time in the reverse direction. No bond failure.

Twist it. Crush it. Manhandle it.

You just can't strip the lead lining away from National Lead's "United Tubond"® lead-lined pipe. The lining will "give" but not the bond.

Look at the test above. Here a mandrel, sized to the ID of the steel pipe minus a few thousandths, is forced through "Tubond" pipe. (A part of the side wall is cut away to show what happens.)

The lead flows, of course, and accumulates below the mandrel. But it doesn't actually pull away from the steel pipe. A thin layer of lead still remains bonded to the steel.

Now look at the twisted and crushed sections. No separation despite massive distortion. With pressure, vacuum, heat, vibration, it's the same story . . . no separation.

What weds the lead to the steel is National Lead's improved bonding process.

Proves virtually indestructible

In service, too, this bond provides an anchorage for the lining that minimizes any chance of acid leakage.

So for maximum corrosion protection, coupled with maximum mechanical strength, specify "United Tubond" pipe. Where conditions are less rigorous you may want to look into "United" expanded lead-lined pipe.

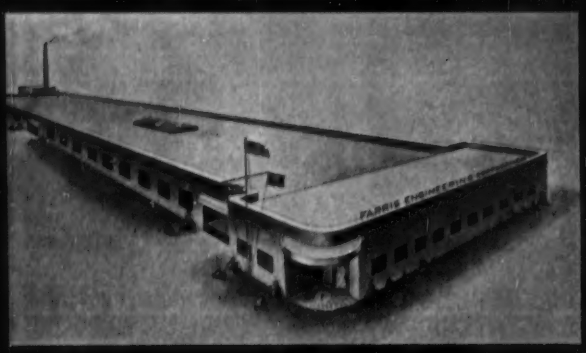
National Lead's technical specialists will be glad to help you work out the technical details of corrosion-resistant systems . . . piping, valves, pumps, coils, tanks and other elements. Just call the nearest office below.

NATIONAL LEAD COMPANY: New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 80; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Co. of Mass.) Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Company, Ltd.).

For more data on advertised products, use Readers' Service Cards, last page.

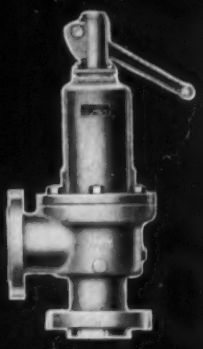
1943

1944

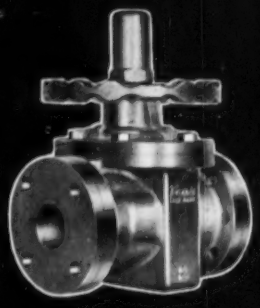


1945

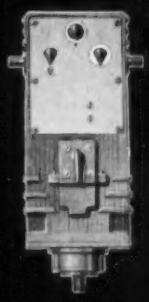
"Progress."



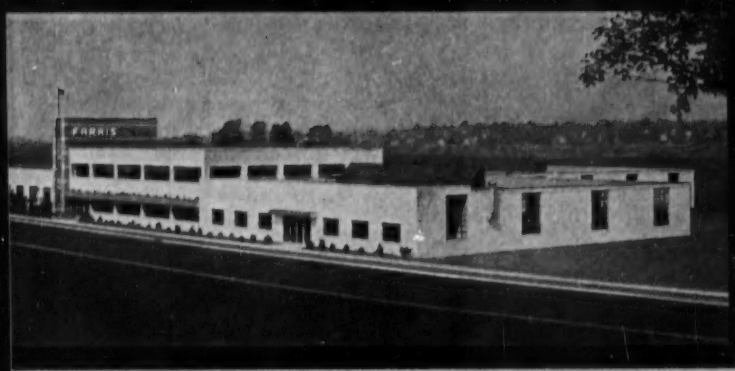
Safety-Relief Valves
Balanseal Bellows Valves
Farris Engineering Corp.



Pinch Type Flexible
Diaphragm Disc and
SuperSeal Valves
Farris Flexible Valve Corp.



Mechanical and
Hydraulic Governors
Farris Pickering
Governor Co., Inc.



1951

U. S. Patents and Patents Pending

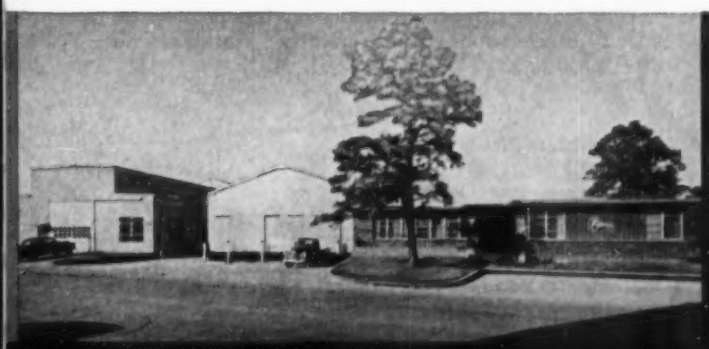
1955

... through honest purpose"

The larger and more experienced a manufacturer becomes, the more he appreciates that PROGRESS is not restricted to simply producing fine products at fair prices. Rather, it is the sum total of all the services he renders to his customers day by day and year by year. It is unceasing vigilance to assure customer satisfaction . . . it is constant concern for improvement—for *better* products at even *better* prices . . . it is strict adherence to a commercial code of honor, like Farris' policy of "Progress—Through Honest Purpose".

Evidence of this policy's success is seen in the rapid and constant growth of the Farris organization. And even as you read this, more facilities are being added . . . designed to provide even greater service for users of Farris Safety and Relief Valves (which have set the pace in design and performance and have been duplicated by other manufacturers), Farris "SuperSeal" Flex Valves and Farris Pickering Governors.

Behind our continuing growth and the world-wide recognition of Farris as a pacesetter in its field, is the fundamental belief that "honesty of purpose" when dealing with people is always to be trusted. Upon this belief we have grown . . . and, because they believe in the same things, our customers and friends have supported us. Here, beyond doubt, is proof that the right way to grow is THROUGH HONEST PURPOSE.



and HOUSTON, TEXAS **1955**

PROGRESS THROUGH Farris HONEST PURPOSE

AFFILIATED COMPANIES

400 COMMERCIAL AVE., PALISADES PARK, N. J.

- Farris Engineering Corp.
- Farris Flexible Valve Corp.
- Farris Pickering Governor Co., Inc.
- Farris Hydrotorque Corp.
- Farris Hydroseal Corp.

How you can save time and money when your blueprint calls for

STAINLESS STEEL PLATE

When your blueprint calls for stainless steel plate, you'll want material of highest quality, produced by specialists in the field, and delivered to you on time. When you want all that, and economy too, you'll find the answer at G. O. Carlson, Inc.

As one of the leading producers of stainless steel plates, heads, rings, forgings, flanges, and other stainless components, G. O. Carlson, Inc. uses the finest equipment in the industry to fill your orders quickly, efficiently and economically. Clean edges are a rule of the road with G. O. Carlson, Inc. which means a minimum of "trueing up" before fabrication. Plates will be rolled promptly to fill special orders, but many of your requirements can be filled from what is probably the largest stock of controlled analysis stainless steel plate available anywhere.

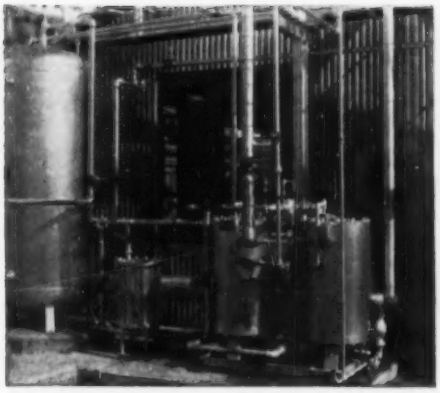
Call Carlson the next time your blueprints specify stainless steel plate or other stainless steel products.

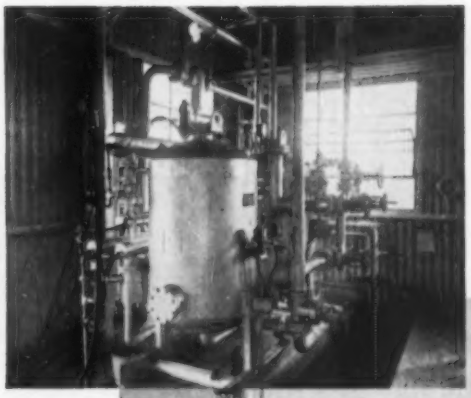
***Stainless Steel Plate* IN STOCK . . .**
Write for Carlson Weekly Stock Lists.
Address: G. O. Carlson, Inc.
Thorndale, Penna.

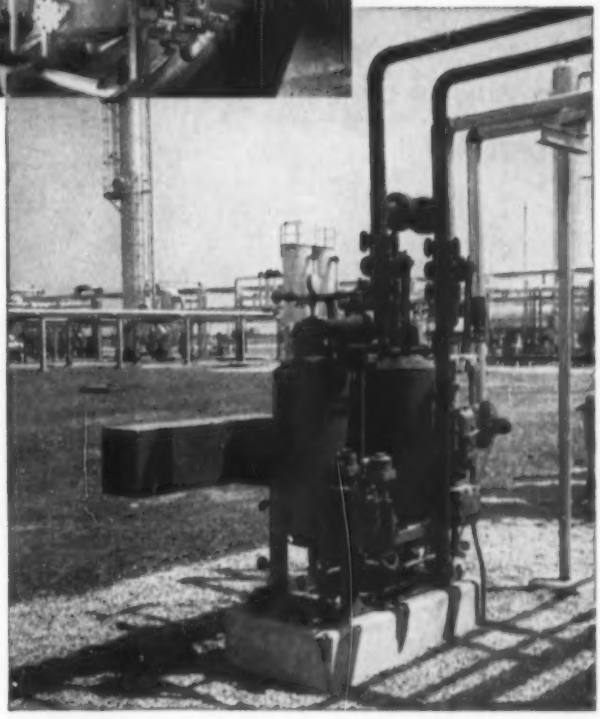
Stainless Steels Exclusively

G. O. CARLSON, INC.

Plates · Plate Products · Forgings · Bars · Sheets (No. 1 Finish)
THORNDALE, PENNSYLVANIA
District Sales Offices in Principal Cities







Because AUTOMATION can't tolerate errors, controls operate on DRY air

Lectrodryer does that DRYing*

THESE INSTRUMENT air driers are typical of many scattered throughout the Petroleum Industry. Some Lectrodryers are huge. But all go about their DRYing job efficiently and dependably, requiring very little attention. They "automate" DRYing.

Pipe lines, natural gasoline plants and refineries assure dependability of their automatic operations by installing Lectrodryers to DRY the air fed to instruments and air-motors. Thus, regardless of weather conditions, there's no moisture in the compressed air to cause freeze-ups, form rust or mud to clog delicate ports.

Add a Lectrodryer to the aftercoolers and separators now on your air system and catch the vaporous moisture that will otherwise cause trouble as the air cools. Bulletin 223-A describes these instrument air driers. For a copy, write Pittsburgh Lectrodryer Corporation, 307 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S.A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

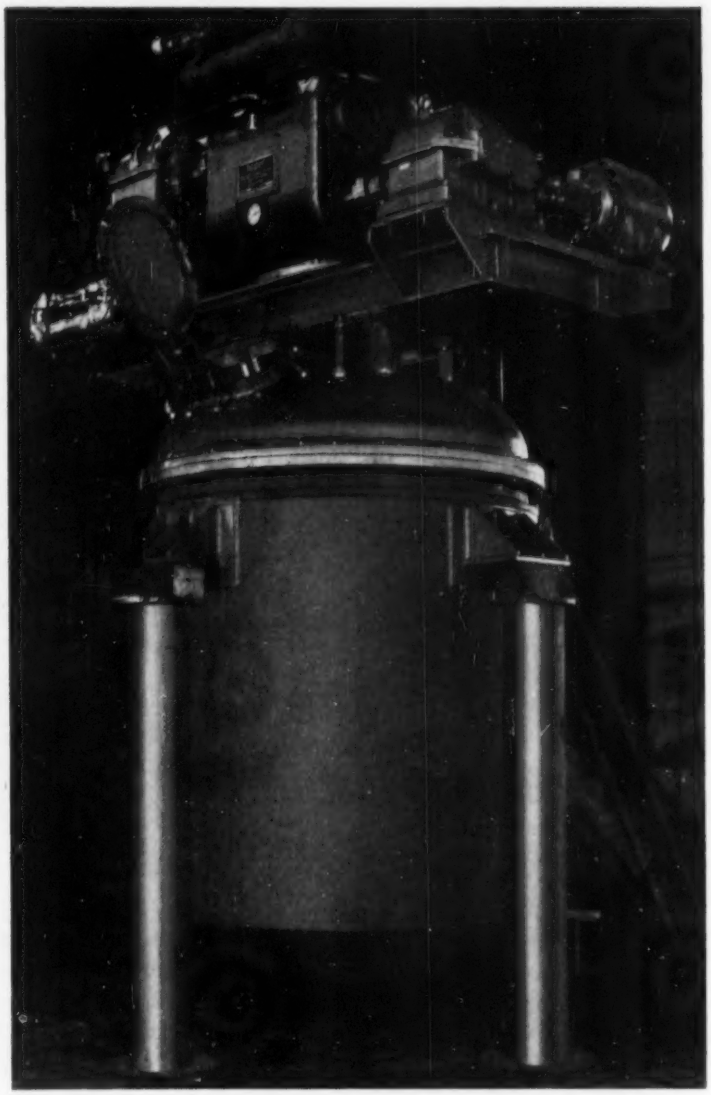
* REGISTERED TRADEMARK U.S. PAT. OFF.

For more data on advertised products, use Readers' Service Cards, last page.

Buflovak Jacketed Grease Kettles are engineered for specific process requirements

...to fit specific processing operation needs

...to provide profitable performance



The kettle illustrated is a Buflovak Jacketed Grease Kettle with a 2500-gal. capacity. It is equipped with a compact 150-hp Cone Gear Drive for operating a Double Motion Agitator, with scrapers, to speed operation. A pneumatic discharge valve saves valuable time. It was designed and engineered by Blaw-Knox engineers to meet the specific requirements of the operation for which it was built.

We can help you solve your kettle problems. Blaw-Knox engineers have had a broad experience in designing and building kettles of every description, from the laboratory—few-gallon, capacity models to ones that process several thousand gallons—not just greases but a large number of varied products. This experience enables our engineers to incorporate in the design of each kettle all the features that are particularly applicable to the operation under consideration. Such features include size of kettle, type of body, agitators, drive, high or low temperature control, method of heating and cooling, heat source, openings and outlets, and so on.

Why not call us and let Blaw-Knox engineers make their recommendations?

A Complete Process Equipment Service

Kettles of every description constitute but one phase of Blaw-Knox Process Equipment design, engineering and fabrication service for the chemical, food, pharmaceutical, plastic and resin, petroleum, rubber and other industries: EVAPORATION • DRYING • FLAKING • MIXING • REACTION IMPREGNATING • VULCANIZING • SOLVENT RECOVERY SOLVENT EXTRACTION • CRYSTALLIZATION • DISTILLATION POLYMERIZATION • GAS CLEANING • GAS ABSORPTION • HEAT TRANSFER • VAPORIZATION • CONDENSATION • STERILIZING LOW AND HIGH PRESSURE PROCESSING

CATALOG NO. 356-R is available on request

BLAW-KNOX

Everything in Process Equipment

BLAW-KNOX COMPANY

BUFLOVAK EQUIPMENT DIVISION

1601 Fillmore Avenue, Buffalo 11, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

New low prices make

Aerocat® catalysts

your biggest bargain!

Cyanamid

- • • first to bring you fully balanced HI PV* Catalysts
- • • leads again in giving you more for less money.

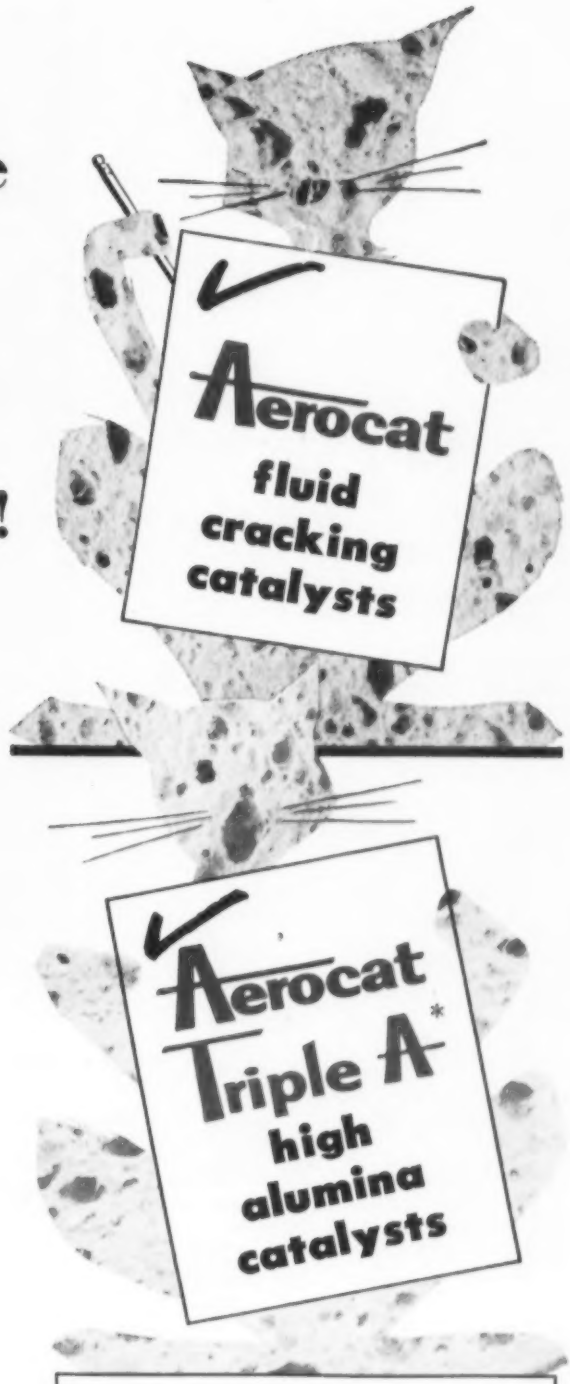
Cyanamid leads the way again by offering you regular and high alumina catalysts at new low prices.

Technological improvements have brought savings that can be passed along to you. And because synthetics give higher octane yields than natural catalysts, these new low prices make AEROCAT Catalysts even greater bargains for the refiner.

Cyanamid has consistently pioneered in bringing you more for your catalyst investment —first to bring you microspheroidal catalyst— first to bring you the greater initial activity of a high alumina catalyst—first to bring you the greater activity stability of a HI PV catalyst.

Cyanamid AEROCAT Catalysts are your biggest bargain today, not only in initial price but in continued efficiency. Ask your Cyanamid representative today for further details.

®Registered trade-mark *Trade-mark



CYANAMID

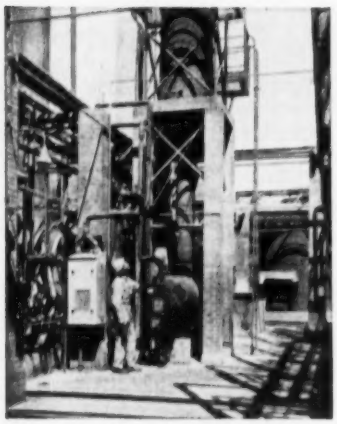
AMERICAN CYANAMID COMPANY
REFINERY CHEMICALS DEPARTMENT
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

For more data on advertised products, use Readers' Service Cards, last page.

Monel-lined HF valve works when needed

Monel-protected HF alkylation plant runs safely on non-stop schedule



Monel-lined HF regenerator resists HF concentrations up to 92% at temperatures to 280°F and pressures to 80 psi.

When to consider Monel for HF alkylation equipment. Monel nickel-copper alloy provides useful resistance to HF in all concentrations and (in unaerated solutions) up to 250°F. It is used with the anhydrous acid at temperatures up to 1100°F. Monel is comparatively unaffected by high stream velocities. Its strength and wear resistance is high.

INCO TRADE MARK Nickel Alloys

Imagine the fire-works if a high octane plant *couldn't* be shut down!

When Continental Oil's Ponca City refinery was constructed during World War II, HF alkylation was new. But gasoline was desperately needed. So even before materials research could be completed, plants had to be built.

Valves were the trouble-makers. Corrosion plus internal stresses cracked them. And corrosion product build-up on critical valving surfaces interfered with operation.

Continental solved this fast. With Monel* nickel-copper alloy welded overlays. (Later they put in solid Monel alloy valves.)

Silver lining goes next

The next thing to go was the silver lining of the acid regenerator. Here sulfur-laden 85-87% acid at 280°F. and 80 psi is present. In 1945, Monel alloy was tried. That did it. Now, tower lining and reboilers, condenser and adjacent piping are all Monel. So are unique liquid level probes within the reboilers. So are relief valves, pump seals, bolts, and acid-propane fractionating tower trays.

*Registered trademark

Now operates non-stop

Today, Continental runs its alkylation units as long as twelve months at a time. Without a halt. Safely. The company estimates Monel saves from 15 to 25% over former operating costs.

Are you having difficulties traceable to HF corrosion? Put the problem up to Inco's Corrosion Engineering Section. You'll get practical help.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

Monel... *for minimum maintenance*

The "Precious Plus" that didn't appear on the Blueprints

You *see* reactors, vessels, towers and piping — and they have the familiar look of any other Paraxylene and Udex plant. But what you *don't see* — what blueprints cannot show — is the "Precious Plus" that earmarks this "a BMC project".

At the time BMC was awarded the design and construction contract, the client had *firm* commitments to ship paraxylene within a fixed time period . . . a time period that would require tight scheduling — even for *conventional* design and construction.

But there was nothing ordinary about *this* Paraxylene plant. It called for a unique crystallizing process — developed by BMC but never before used — that would require time-consuming creative engineering.

Working under almost prohibitive time pressures, a BMC Task Force — with the *Key Man*+ in charge — tackled the job. There was no waste motion in engineering. Drafting geared itself to a back-breaking schedule. Equipment orders were placed early. Usual "bugs" were anticipated — and avoided.

The plant went "on-stream" ahead of the client's *fixed* schedule . . . and first shipments were on their way well in advance of the contract commitments. Cost? Substantially below the estimate despite the emphasis on speed.

You can't see it . . . you pay nothing for it . . . but the "Precious Plus" included in this project is a part of every BMC proposal. Many leading petroleum and petrochemical companies have found it a distinct advantage in getting better plants, faster and at a lower cost. How else explain the unusual growth BMC is enjoying?

The Udex and Paraxylene Plants described here were designed and constructed for Sinclair Refining Company, Marcus Hook, Pa.

\+ BMC's *Key Man* operation is unique among major contract engineering firms. The BMC man who submits your proposal is *always* a BMC principal . . . *always* the Key Man heading up the Task Force responsible for the execution of your job. Clients tell us "This is the BMC difference that makes the difference."

BMC

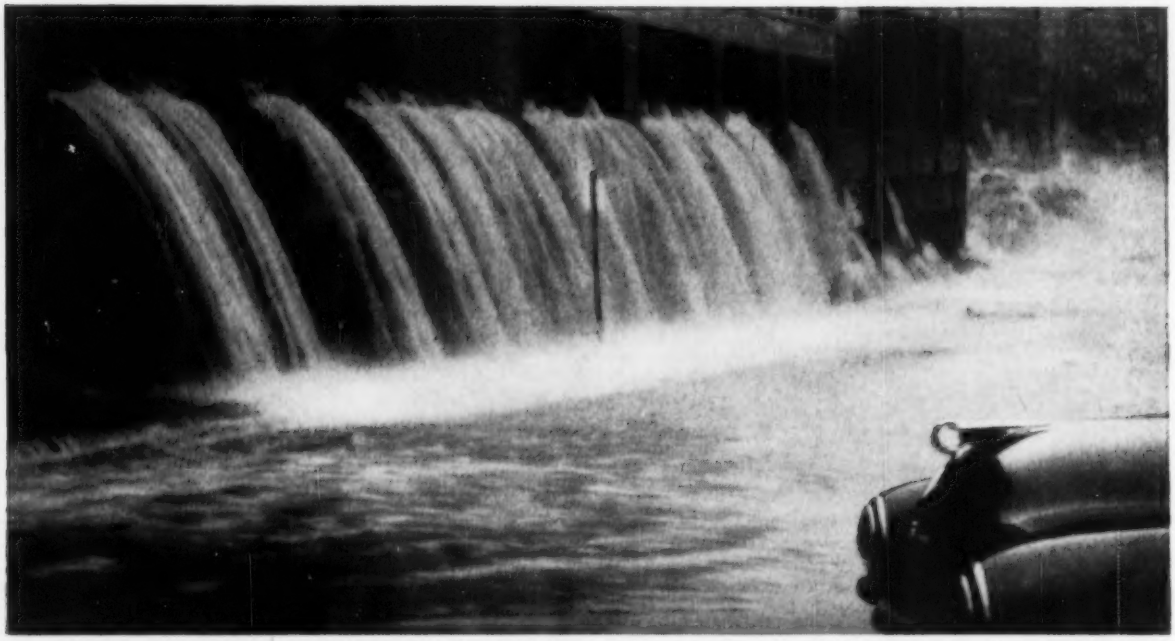
BADGER MANUFACTURING COMPANY

230 Bent Street, Cambridge 41, Mass.
60 East 42nd Street, New York 17, New York

ENGINEERS • CONTRACTORS • DESIGNERS • MANUFACTURERS

BRISTOL FIELD SERVICE...

Bright spot in a



Height of flood at American Brass Company, Casting Shop, Torrington Division. More than 125 instruments were serviced in this customer's Naugatuck Valley plants. In addition, instruments returned to Bristol for repair included: 17 electronic potentiometers, 62 thermometers and gauges, 69 running count recorders, and 47 electric controllers. First instruments were returned to customer in 6 days; all others were returned by the customer's deadline.

More than 150 instruments serviced in inundated plants of United States Rubber Company, plus 10 electronic instruments, 31 thermometers and gauges, 9 electric controllers, 5 pneumatic controllers which were removed to Waterbury for service. First instruments returned to customer in 3 days; all returned by customer's deadline.

For more data on advertised products, use Readers' Service Cards, last page.

Black Friday

Bristol engineers give flooded areas fast repairs without slowing service to other areas

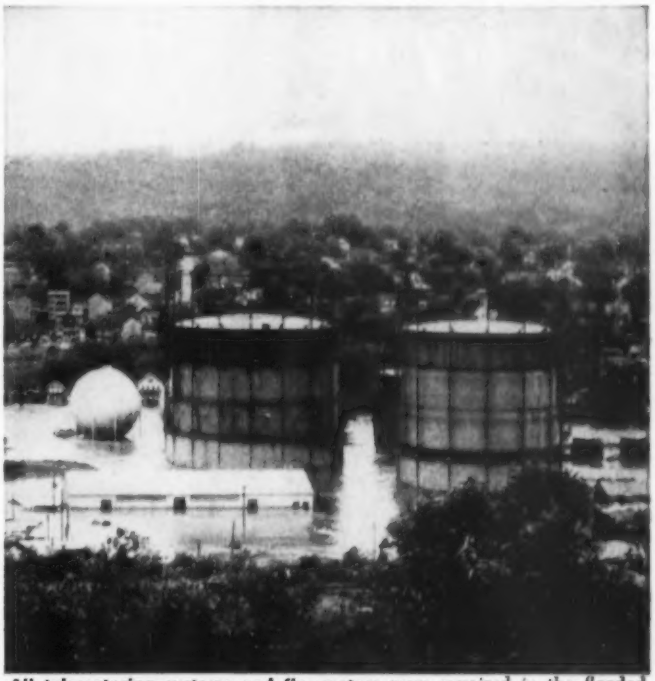
On Friday, August 19, 1955, raging flood waters in the wake of hurricane Diane inundated and battered hundreds of East Coast industrial plants, heavily damaging buildings and equipment.

Fortunately, though our bridge was lost and utilities were cut off for a few days, the Bristol Company at Waterbury, Connecticut, escaped damage.

Repair service on the double

Even before the flood waters receded, Bristol service engineers were on the job, repairing the hundreds of Bristol recording and controlling instruments damaged by water, silt and debris, contributing in an important way to the recovery of this stricken area—with no sacrifice to Bristol customers in other parts of the country.

Working in mud and filth, Bristol servicemen repaired instruments right in the plant wherever possible. Where heavier damage took place, instruments were returned to Waterbury for repair or replacement. Back-in-service records for three heavily hit plants are shown on these pages, together with pictures of the flood damage.



All telemetering systems and flowmeters were repaired in the flooded plants of a large public utility in Connecticut. Eight thermometers and gauges too badly damaged for repair were replaced. All instruments delivered to customer in seven to nine days!

Every customer's deadline was met

HUNDREDS OF INSTRUMENTS from plants other than those shown were also serviced. They were repaired in the plant, if possible, or picked up in the most convenient location for the customer, repaired at Bristol, then returned and reinstalled. The deadline set by the customer was met in every case. Instruments were often replaced and operable before the remainder of the plant.

Flood or no flood, this is the kind of service you can expect when you deal with Bristol. In 38 cities across the U. S. and Canada, Bristol service centers, with factory-trained servicemen, stand ready to solve your every maintenance or repair problem. From coast to coast you are as close to your Bristol service center as to your telephone. The Bristol Company, 111 Bristol Road, Waterbury 20, Conn. 5.46

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Here's Stainless Steel used for SO_2 drying

This primary drying tower operates at 200° F., and it is used to dry sulfur dioxide. As every engineer knows, it only takes a little bit of water to turn the sulfur dioxide into sulfurous acid. Because of this, the tower is made of solid Type 316 Stainless Steel. The reboiler is a solid Type 316 with Type 317 tubes.

Every refinery is a showplace for Stainless Steel, because no other metal combines so many desirable properties. When *designing* with Stainless Steel, remember that United States Steel can furnish a greater variety of grades, types, sizes and finishes of Stainless Steel.

Continental Oil Refinery No. 3, Lake Charles, Louisiana

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

USS SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE SPECIAL SECTIONS

UNITED STATES STEEL

REFINERY-PROVED

HOUDRESID

PROCESS

ELIMINATES PRODUCTION OF HEAVY RESIDUAL FUEL

- Over 2 years refinery experience
- No heavy metal contamination problem
- Uses synthetic or natural clay catalysts

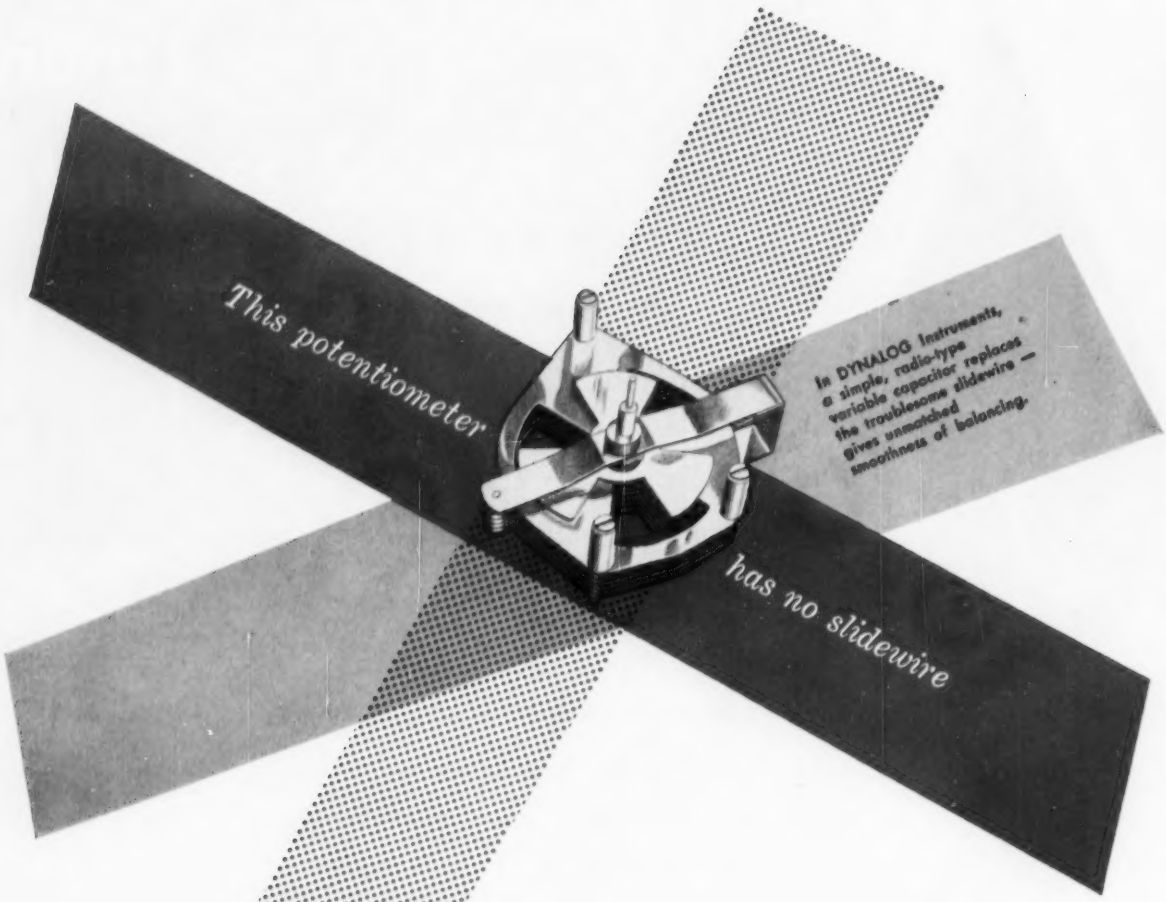
The Houdresid Process eliminates the production of heavy residual fuel by making it practical and economical to catalytically crack the bottom of the petroleum barrel. This refinery-proved, continuous moving bed process converts reduced crudes into exceptional yields of high-octane gasoline and light distillate fuel. The process is well adapted to the use of synthetic or natural clay catalyst, and to the charging of a wide range of reduced crudes.

The problem of heavy metal contamination usually associated with catalytic cracking of residua has been successfully eliminated by the Houdresid process. This has been conclusively demonstrated in both pilot plant and commercial refinery operations. One commercial Houdresid unit has been in operation for over 2 years.
Write today for further information.

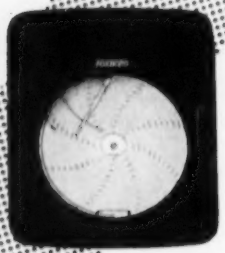
HOUDRY

PROCESS CORPORATION
Pioneer in Catalytic Processes
1528 Walnut St., Philadelphia 2, Pa.

For more data on advertised products, use Readers' Service Cards, last page.


This potentiometer
has no slidewire
In DYNALOG Instruments, a simple, radio-type variable capacitor replaces the troublesome slidewire — gives unmatched smoothness of balancing.

STEPLESS CAPACITY-BALANCING
ELIMINATES STANDARDIZING!



DYNALOG'S EXCLUSIVE BALANCING ACTION

- no slidewire
- no batteries
- no standardizing
- no gears, cables, etc.
- no high-speed reversing motor

Here's the potentiometer that's *never* "off process" for standardizing. It requires none! The Dynalog's advanced, stepless-balancing design eliminates dry cell, provides *direct, uninterrupted* evaluation of the measured variable with sustained high accuracy.

Dynalog* design eliminates slidewire maintenance and motor servicing too! A simple, variable capacitor and positive magnetic drive provide smooth, continuous balancing action . . . instant response without wear. There are no fast-moving parts . . . no gears, cables, or complicated mechanisms. Only five moving parts, including the recording pen!

Dynalog Instruments are available for use with resistance, voltage, capacity, or inductive type primary elements to measure and/or control any process variable. For complete details, write for Bulletin 427. The Foxboro Company, 742 Neponset Ave., Foxboro, Mass., U.S.A.

*Reg. U. S. Pat. Off.

FOXBORO DYNALOG
Reg. U.S. Pat. Off.
ELECTRONIC INSTRUMENTS

For more data on advertised products, use Readers' Service Cards, last page.

Versatile? Yes!

These are Rheem steel pails. They are available in 1-gallon to 15-gallon sizes; plain, colored or lithographed; lined or unlined; double head or crimp lug type covers. To the many manufacturers who want clean steel pails, Rheem is the answer. You see, Rheem is the world's largest manufacturer of steel containers, and their experience is your assurance that your products are well protected—always. Rheem pail linings are bonded directly to the steel and oven baked by a special process to stay on. Use the coupon to find out more about sending your products to market, first class—in Rheem steel pails.

YOU CAN RELY ON Rheem MANUFACTURING COMPANY

World's Largest Manufacturer of Steel Shipping Containers

LINDEN, N. J. AND SPARROWS POINT, MD., RICHMOND AND SOUTH GATE, CALIF., HOUSTON, CHICAGO, NEW YORK, NEW ORLEANS

RHEEM MANUFACTURING COMPANY
5001 Jefferson Highway, P.O. Box 4027, Carrollton Station, New Orleans 18, La. 1025 Lockwood Drive, Houston, Texas.
Please send me detailed information on Rheem Steel Pails.

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ STATE_____

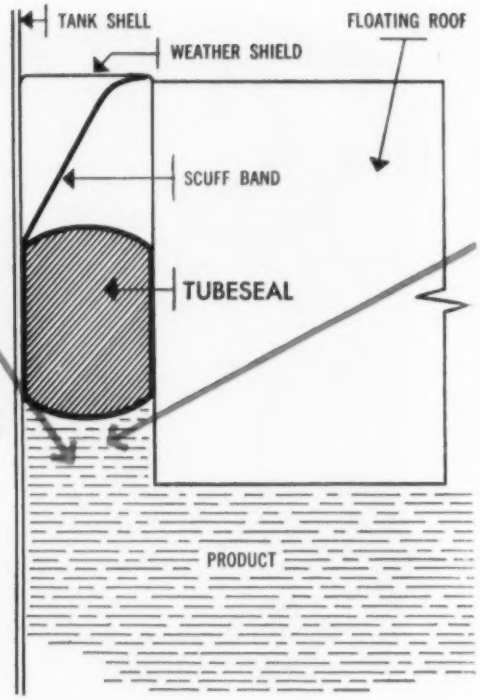
PR 2

For more data on advertised products, use Readers' Service Cards, last page.

THE SECRET OF A GOOD FLOATING ROOF:

NO ROOM FOR VAPORS*

*NO EVAPORATION
NO FIRES
MINIMUM CORROSION



Because there is no space in a HAMMOND TUBESEAL FLOATING ROOF, where vapor can form, jet fuels and other volatile products can be stored with assurance that evaporation and fires cannot take place and further that corrosion will be kept to a bare minimum.

THE HAMMOND TUBESEAL

The most efficient and positive seal known: no moving parts · no mechanical maintenance · climate proof · non-corrodible · can operate to bottom of tank or above the top · no vapor space below the seal · entire circumference has tight seal under pressure at all times.

LICENSES AVAILABLE

The makers of TUBESEAL believe that its unique safety and economy factors should be allowed to benefit the broadest possible section of the petroleum industry. For that reason HAMMOND IRON WORKS will license its use on a non-exclusive basis. For further information write to:

HAMMOND IRON WORKS,
Warren, Pa.

Sales Offices:
NEW YORK 20
AKRON
BOSTON 10
BUFFALO 2
CHICAGO 3
CINCINNATI 2
CLEVELAND 15
EL PASO
HOUSTON 2
LOS ANGELES 14
PITTSBURGH 19
RICHMOND 20
SAN FRANCISCO
WASHINGTON 6, D.C.
HAVANA
MEXICO CITY
"TIPSA" BUENOS AIRES
Licensee in Cal.:
LACY MFG. CO.,
LOS ANGELES
Licensee in Canada
BRIDGE & TANK CO.

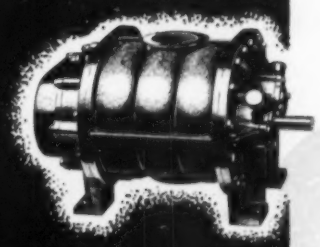
HAMMOND TUBESEAL* COSTS NO MORE IN THE FIRST PLACE

* Patent applied for

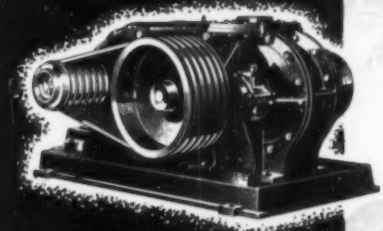
ask for Bulletin TS

CHEAPER OVER THE YEARS

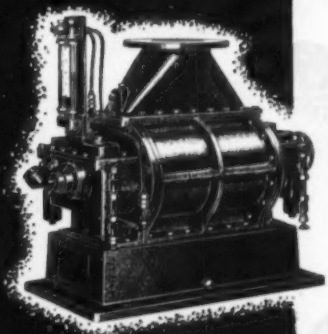
HAMMOND
IRON WORKS
WARREN and BRISTOL, PA. • PROVO, UTAH
CASPER, WYO. • BIRMINGHAM, ALA.



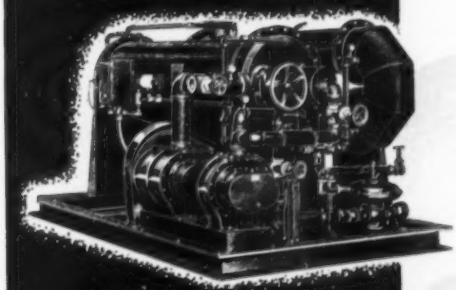
BLOWERS for such widely varying needs as lifting a damaged airplane or injecting air into water to provide oxygen for safe transportation of fish in tanks. Capacities as low as 5 cfm or up to 100,000 cfm or higher.



GAS PUMPS for inflating balloons, manufacturing electronic tubes or extracting gases from contaminated areas for test samples. They'll deliver as little as 5 cfm or as much as 50,000 cfm or more.



METERS help save money or make more profits by accurately measuring almost any kind of gas which you buy, sell or use in manufacturing processes. "Cash register accuracy" from 2,000 to a million cfh.



INERT GAS GENERATORS make hazardous operations safer from fire or explosion. They protect people, plants and products . . . and often return more than they cost in reduced insurance premiums. They'll produce inert gas for almost any use. You can have as much as 50,000 cfh or as little as 1,000 cfh in mobile or stationary equipment.

How to pull DOLLARS out of the AIR

New ways to put air (or gas) to useful, profitable work are constantly being developed by engineers and designers. These result in more effective machines and devices—frequently replacing slower or more expensive methods—often reducing the first cost of the equipment itself. These results are accomplished . . .

by resourceful engineering

In many of these applications, designers and engineers have utilized standard R-C equipment, sometimes with special adaptations. The problem may call for a small or large volume of air, moved by R-C Blowers or Exhausters. It may require vacuums, produced by R-C Vacuum Pumps. Perhaps metering or pumping of gas is needed, also met by R-C products. In any event, the solution is often . . .

aided by Roots-Connersville experience

If you use or build for resale any product which might be improved by utilization of air at moderate pressures, by vacuums or by moving gas, perhaps we can help you. Even if you have only the ghost of an idea that might pull dollars out of the air, we'll gladly work with you.

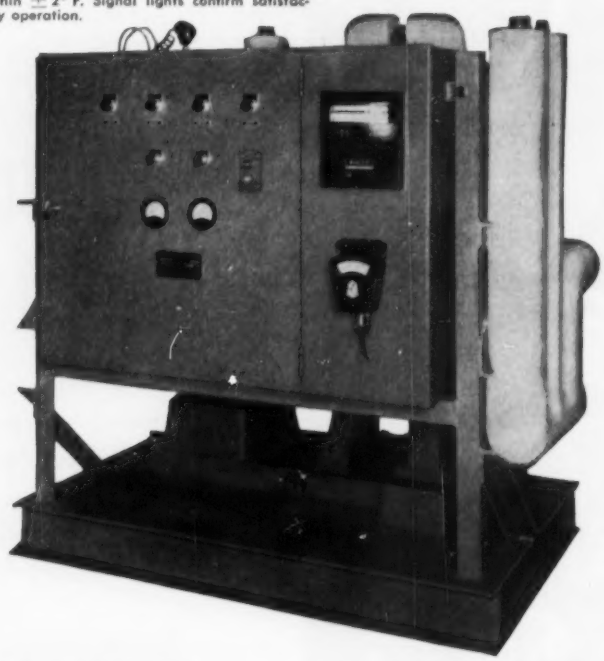
Just address:
Product Development Manager, Roots-Connersville Blower Division, 256 Crescent Ave., Connersville, Indiana.

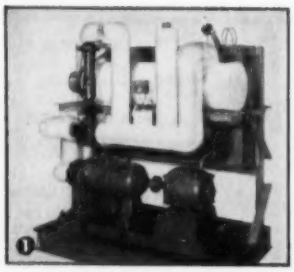
ROOTS-CONNERSVILLE BLOWER
ONE OF THE DRESSER INDUSTRIES

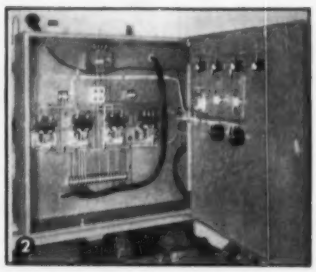
For more data on advertised products, use Readers' Service Cards, last page.

A COMPLETE TRANSFER OIL HEATING SYSTEM In one compact "PACKAGE"

Instruments and controls are substantially flush mounted. Temperature controls are carefully selected to maintain oil supply temperature within ± 2° F. Signal lights confirm satisfactory operation.







1. The system is compactly arranged to conserve space. To obviate leaks, pipe connections are welded wherever possible. The heavy pipe insulation is securely wired and wrapped with cemented canvas.

2. The workmanlike electrical system provides easy-to-trace circuits. All wire of high current capacity is heavy cross section.

WHITLOCK has developed a standard "package", with ratings of 10 to 50 KW, which includes heater operating controls and expansion tank to heat chemically stable transfer oils. Since these oils are liquid over considerable temperature ranges, they are being used increasingly in chemical processing operations. The heating equipment, previously of special design, is now available as a complete, standardized unit to which only oil and electrical connections need be made in order to permit immediate operation.

The combination of low liquid pressures and high liquid temperatures eliminates the need for the application of high pressure design techniques to many current processes. This new "package" effectively serves to reduce overall equipment costs and to simplify process design.

For additional information and prices, write The Whitlock Manufacturing Company, 75 South Street, West Hartford 10, Conn. In Canada: Darling Brothers, Ltd., Montreal.

Whitlock

Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers

For more data on advertised products, use Readers' Service Cards, last page.

THE NEW **CHIKSAN**

Hydraulically Controlled

MARINE LOADING ARM

The first basic improvement for loading and unloading of petroleum products in over 30 years.

- Speeds tanker turn-around-time
- Far less manpower to operate
- Long life, trouble free operation
- Elimination of hose bursts
- Lowers fire and work compensation premiums
- Operates from −60°F. to +225°F.
- One motor, one switch controls operation
- Static and spark resistant
- No manhandling of hose

CHIKSAN COMPANY; Brea, California

Please send me more information on the Chiksan Marine Loading Arm.

Name_____

Company_____

Address_____

City_____ Zone___ State_____

52

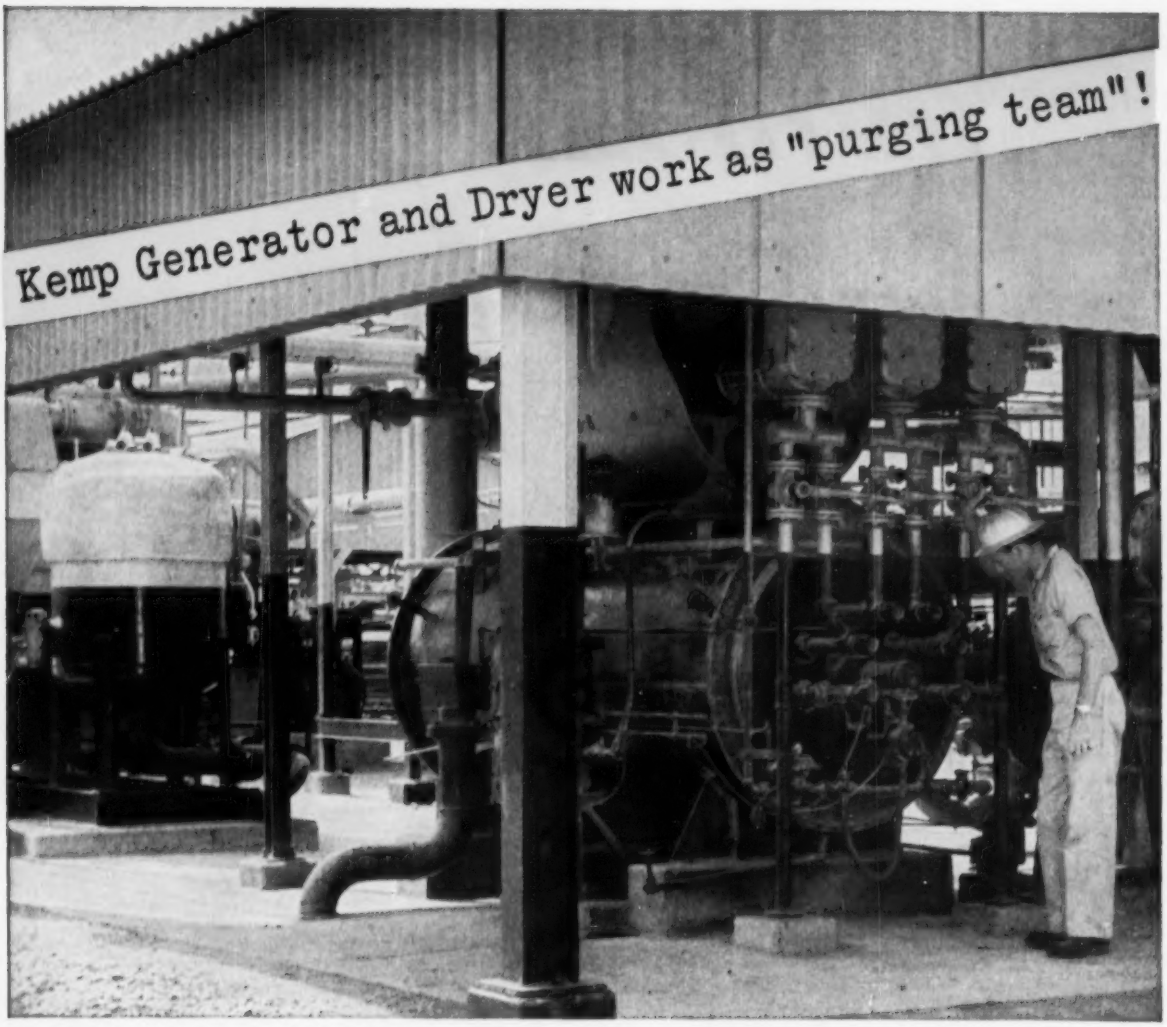
CHIKSAN

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

fmc

CHIKSAN COMPANY—BREA, CALIFORNIA • CHICAGO 3, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif., Newark 2, N. J. • Chiksan of Canada, Ltd., Edmonton, Alta.



Gulf Oil Reports: *Pipe line purging problems solved by Kemp Gas Generator and Kemp Dryer*

At Gulf Oil's Port Arthur, Texas refinery, dry inert gas is required in the Ethylene Plant for purging pipe lines, tanks and vessels.

Kemp Units selected to do the job

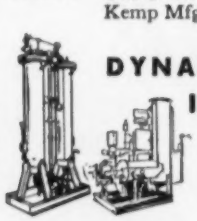
To insure a constant supply of gas—sufficiently dry and free of oil vapors—Gulf installed both a Kemp Inert Gas Generator and a Kemp Convection Type Dryer. The units work as a "purging team"...the Kemp Generator produces 30,000 SCFH of inert gas which is compressed and passed through a Kemp Pre-filter to remove all moisture prior to entering the gas receiver. The result is an efficient, easily controlled source of dry inert gas at all times.

Kemp can solve your problem too

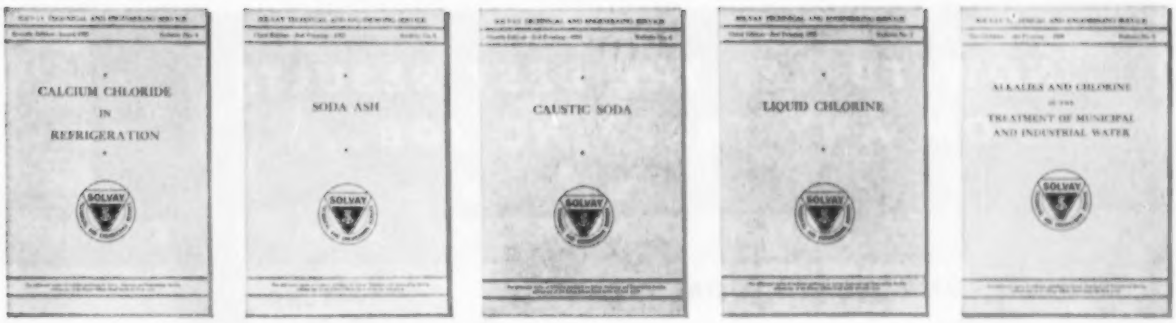
Whether your needs involve dry gases, inert gases—or both, Kemp can help you to the most profitable solution. Kemp Inert Gas Generators automatically deliver clean, controlled atmospheres at specific analysis, without fluctuation—regardless of demands. A variety of Kemp Dryers are designed to dry air, gases or liquids to sub-zero dew points and are available with manual, semi-automatic or fully automatic tower reactivation. In addition, Kemp will specify the proper desiccant for the job.

For complete facts and technical information on Kemp Inert Gas Generators and Kemp Dryers, write today to: The C. M. Kemp Mfg. Co., 405 East Oliver St., Baltimore 2, Maryland.

KEMP OF BALTIMORE



DYNAMIC DRYERS
INERT GAS GENERATORS
CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • SINGEING EQUIPMENT



THESE SOLVAY TECHNICAL BULLETINS

ARE AVAILABLE TO YOU

Contain data, research material and analytical procedures for ready reference — detailed information that may help you improve your present process.

SOLVAY's Technical and Engineering Service Bulletins cover a wide scope of subjects. Their range includes: the physical and chemical properties, use, handling and storage of SOLVAY products...procedures to be followed in analysis of water, liquid chlorine and bleach . . . the use of calcium chloride in refrigeration . . . and the treatment of municipal and industrial water with alkalies and chlorine.

These highly informative books were written by SOLVAY's staff technicians and engineers. They contain standard tables and charts along with original data compiled from field experience and research by members of the world's largest alkali laboratory.

All of SOLVAY's Technical and Service Bulletins are available without cost or obligation.* Just fill in the coupon below.

*In Western Hemisphere Countries

AMERICA'S FIRST PRODUCER OF ALKALIES — SOLVAY — 75th YEAR 1881-1956

Soda Ash • Snowflake® Crystals • Potassium Carbonate
Calcium Chloride • Ammonium Bicarbonate • Sodium Bicarbonate
Cleaning Compounds • Caustic Potash • Sodium Nitrite • Chlorine
Caustic Soda • Ammonium Chloride • Para-dichlorobenzene
Methyl Chloride • Ortho-dichlorobenzene • Monochlorobenzene
Carbon Tetrachloride • Chloroform • Methylene Chloride
Hydrogen Peroxide

Allied Chemical

SOLVAY PROCESS DIVISION
ALLIED CHEMICAL & DYE CORPORATION
61 Broadway, New York 6, N. Y.

Gentlemen: Please send me without cost or obligation,* the SOLVAY Technical and Engineering Service Bulletins I have checked:

- ☐ No. 4—Calcium Chloride in Refrigeration
- ☐ No. 5—Soda Ash
- ☐ No. 6—Caustic Soda
- ☐ No. 7—Liquid Chlorine
- ☐ No. 8—Alkalies and Chlorine in the Treatment of Municipal and Industrial Water
- ☐ No. 9—Analysis of Alkalies
- ☐ No. 11—Water Analysis
- ☐ No. 12—The Analysis of Liquid Chlorine and Bleach
- ☐ No. 14—Chlorine Bleach Solutions
- ☐ No. 16—Calcium Chloride

Name _____

Organization _____

Address _____

City _____ Zone _____ State _____ BF-2

*In Western Hemisphere Countries

For more data on advertised products, use Readers' Service Cards, last page.

HOW TO GET THE BEST RESULTS FROM ANY TRAPPING JOB...

DRAINING CONDENSATE FROM STEAM

How to correctly size, install and maintain steam traps for any pressure, any temperature, any load... Armstrong inverted bucket trap design principles and advantages . . . sizes, list prices, physical data, capacities . . . data on variable loads, warming-up loads, submerged coil heat transfer, steam main and riser drainage... trapping of unit heaters... power plant trapping, and many other subjects. ASK FOR 44-PAGE CATALOG J, The Armstrong Steam Trap Book.

DRAINING LIQUIDS FROM AIR AND GAS

How to select and install ball float traps for draining light liquids or water from drip points, aftercoolers, separators, etc., in compressed gas and air systems . . . liquid level control hookups . . . high pressure trapping to 1000 psig . . . trap materials for corrosive service . . . capacities, physical data, list prices, single lever, compound lever and "snap-action" traps. ASK FOR BULLETIN 289.

VENTING AIR AND GAS FROM LIQUIDS

Selection and installation of ball float traps for venting air and gas from water and light liquids under pressure . . . contains useful table on air discharge through various size orifices at pressures from 1 to 1000 lbs. . . . when and how to back vent traps . . . floats and mechanisms for other manufacturer's devices . . . sizes, list prices, materials, dimensional data for Armstrong Ball Float AR Traps. ASK FOR BULLETIN 450.

DRAINING WATER FROM LIGHT LIQUIDS

Dual gravity trap selection and installation explained and diagramed . . . for draining gasoline separators, dehydrator tanks, debutanizers, etc. . . . orifice capacity data, dimensions, materials, list prices for Armstrong Ball Float D/G Traps. ASK FOR BULLETIN 2091.

Free on request without obligation—call your local Armstrong Representative, or write Armstrong Machine Works, 852 Maple Street, Three Rivers, Michigan

ARMSTRONG

INVERTED BUCKET and BALL FLOAT TRAPS FOR THE PETROLEUM INDUSTRY

THE SURFACE IS IMPORTANT!

In heat exchange applications, the condenser tube surface is vitally important. By increasing the surface area, heat duty is increased, costs reduced and on-stream time greatly lengthened.

Wolverine Trufin* Type S/T will produce this end result! Type S/T obtains its increased surface area from its fins which are squeezed directly from the tube wall. Because of its extruded fins, Trufin packs more heat transfer surface into every foot of tube—steps up capacity by as much as 2½ times over prime surface tube. Trufin makes it possible to design smaller, more effective heat exchangers and condensers. When retubing with Trufin Type S/T you obtain a much greater heat transfer surface area and thus can increase the capacity of your unit.

Since its fins are actually a part of the tube wall, they cannot shake loose because of vibration, thermal shock or varying pressures. Under the most severe operating tests, Trufin has proved conclusively that it withstands fouling for longer periods than does prime surface tube. Trufin-tubed units go on-stream and stay on-stream. Efficiency is constant, costly maintenance time reduced.

Trufin Type S/T can be directly substituted for plain tube with conventional tools and methods. The ends of the tube are left without fins and the tube is designed with the outside diameter of the plain end slightly larger than the O.D. of the finned end. This allows the tube to be inserted into a bundle and rolled into the tube sheet by regular methods.

Yes, surface is important and Trufin has the surface you need. Next time you order condenser tube specify Trufin Type S/T. It is available in a wide range of sizes and alloys of copper and aluminum. Write, too, for your copy of the Wolverine Trufin Opportunity Book. It's packed with valuable information.

WOLVERINE TUBE, 1437 Central Avenue, Detroit 9, Michigan.

REG. U.S. PAT. OFF.

This is Wolverine Trufin* Type S/T—the integral finned condenser tube with the extended surface that means increased performance and economy.

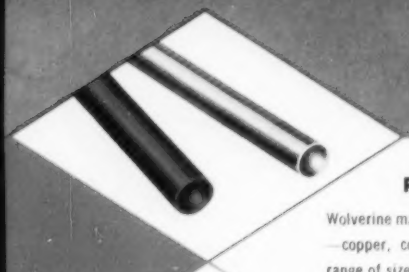
WOLVERINE TUBE

Division of Calumet & Hecla, Inc.

MANUFACTURERS OF QUALITY-CONTROLLED TUBING AND EXTRUDED ALUMINUM SHAPES

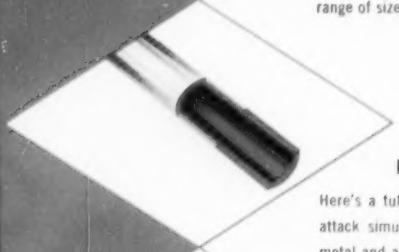
PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK



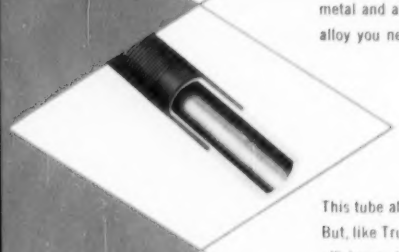
PRIME SURFACE TUBE

Wolverine manufactures prime surface tubing in two metals—copper, copper-base alloys and aluminum in a wide range of sizes.



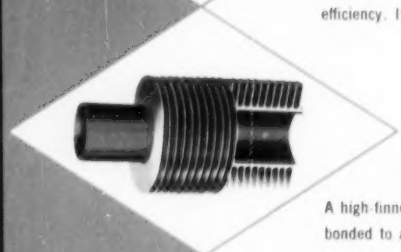
DUPLEX PRIME SURFACE TUBE

Here's a tube designed to handle two types of corrosive attack simultaneously. It is composed of a tube of one metal and a liner of another. The combination can be any alloy you need to meet special conditions.



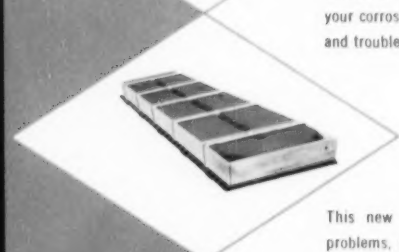
DUPLEX TYPE S/T

This tube also is designed for specific corrosive conditions. But, like Trufin, it has integral fins—will boost heat transfer efficiency. It can be used instead of prime surface tube.



TRUFIN TYPE L/C

A high-finned, lightweight aluminum tube is mechanically bonded to an interior liner of the alloy which best beats your corrosion hazard. It provides maximum heat transfer and trouble-free performance at low cost.



U-BEND PALLETS

This new Wolverine idea cuts time, reduces storage problems, and saves money. U-bend condenser tubes—either finned or prime surface—are arranged in a disposable box-type pallet in the exact order you specify. All you have to do is feed them directly from pallet to unit.

FIELD ENGINEERING SERVICE

This is a Wolverine "extra"—a staff of highly-skilled tubing technicians. You can get experienced help in solving problems dealing with alloys, corrosion, design or fabrication.

*REGISTERED U.S. PATENT OFFICE.

BACKED BY EXPERIENCE

In addition to Trufin* Type S/T, Wolverine has also pioneered in the development of a complete line of condenser tubes for the processing industry. Such a line-up could only come from years of experience—the kind of experience that studies an industry's needs and then develops products to meet those needs.

Illustrated are condenser tubes designed to bring new efficiency to every type of operating condition. Each is the product of Tubemanship—Wolverine's way of combining experience, research, rigid quality control and sound engineering into every foot of every tube.

Look these products over—study them in relation to your own operating needs—and then specify the one that will do the job. Wolverine's Condenser Tube Catalog contains complete size and alloy information. Write for your copy today!

WOLVERINE TUBE, 1437 Central Avenue, Detroit 9, Michigan.

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.

MANUFACTURERS OF QUALITY CONTROLLED TUBING AND EXTRUDED ALUMINUM SHAPES

Wolverine Trufin available in Canada through the Unifin Tube Company, London, Ontario.

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK

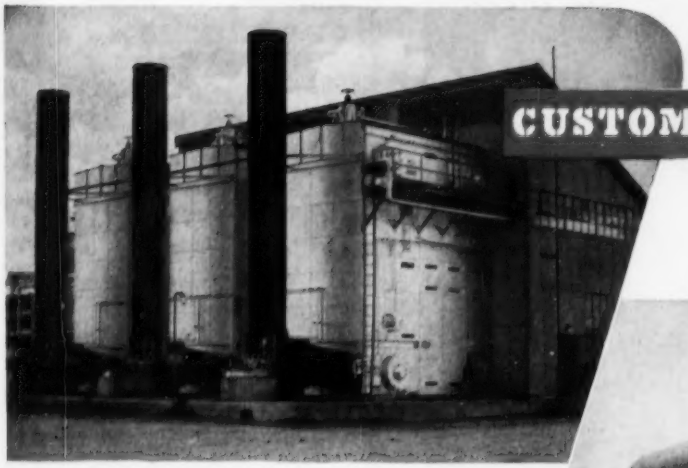
Roughnecks...

Did you ever watch a good team of roughnecks in action? They make the orderly racking of the long sections of drill pipe and the handling of other heavy "pig iron" look easy. When the replacement of a dull bit interrupts the quest for pay sand, they're hustling: hoisting, disconnecting and racking drill pipe to get a new bit back on bottom and start making hole again—for "making hole" is making money and every minute saved in other operations is money saved, and a lot of it. That's where the skill and teamwork of good roughnecks make the difference.

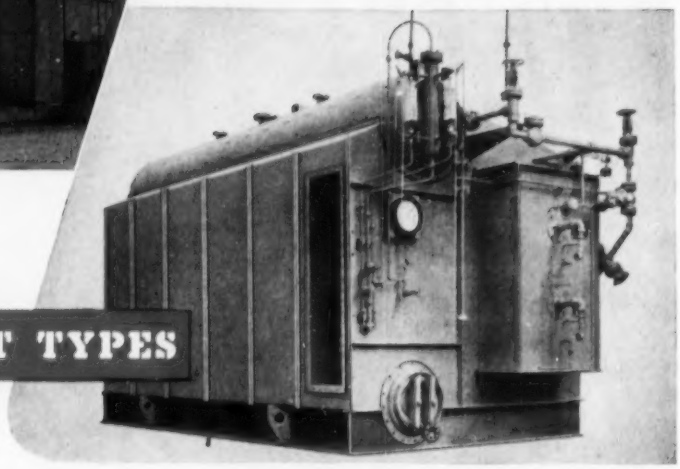
The Texas Company

TEXACO

For more data on advertised products, use Readers' Service Cards, last page.



CUSTOM BUILT TYPES



PACKAGE UNIT TYPES

Stop 'n Shop at Vogt

for modern Steam Generators

Types and Sizes for Every Power, Processing and Heating Requirement

Steam costs too high? Then it's high time to replace outmoded boilers with modern Vogt steam generators of the type and size to exactly fit in with specific operating conditions.

Vogt steam generators are designed to give maximum rating in minimum space, with high efficiency and low maintenance expense. They are available in bent tube types and straight tube, forged steel sectional header types for solid, liquid or gaseous fuels burned singly or in combination.

Package units range from 10,000 to 30,000 pounds capacity and custom built units are obtainable in the larger capacities. Many installations in successful operation are proof of Vogt's ability to give effective help in the solution of steam generating problems. Bulletins may be had upon request.

Address Dept. 24-BPR

HENRY VOGT MACHINE CO.
LOUISVILLE, KENTUCKY

Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

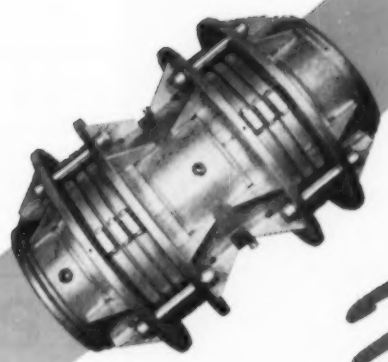
For more data on advertised products, use Readers' Service Cards, last page.

LOOKING FOR AN "ALL PURPOSE" EXPANSION JOINT?

Zallea has never built one—never will. And for good reason. Like all precision engineered equipment, Zallea Expansion Joints are designed to fill specific rigid requirements. In every case, types, sizes and materials of construction are determined by factors of temperature, pressure, traverse and special service conditions.

Zallea Brothers design and build expansion joints for every requirement of modern industry. Field tests have proved the value of our emphasis on designing the expansion joint to fit the problem. Records show that Zallea Expansion Joints outlast all other packless expansion joints from 90% to as much as 1200%. Such reliability is further proof of Zallea design superiority.

Zallea representatives are always ready to help solve problems relating to expansion joints. Or if you prefer, write for Bulletin 351 which describes the many standard types available.



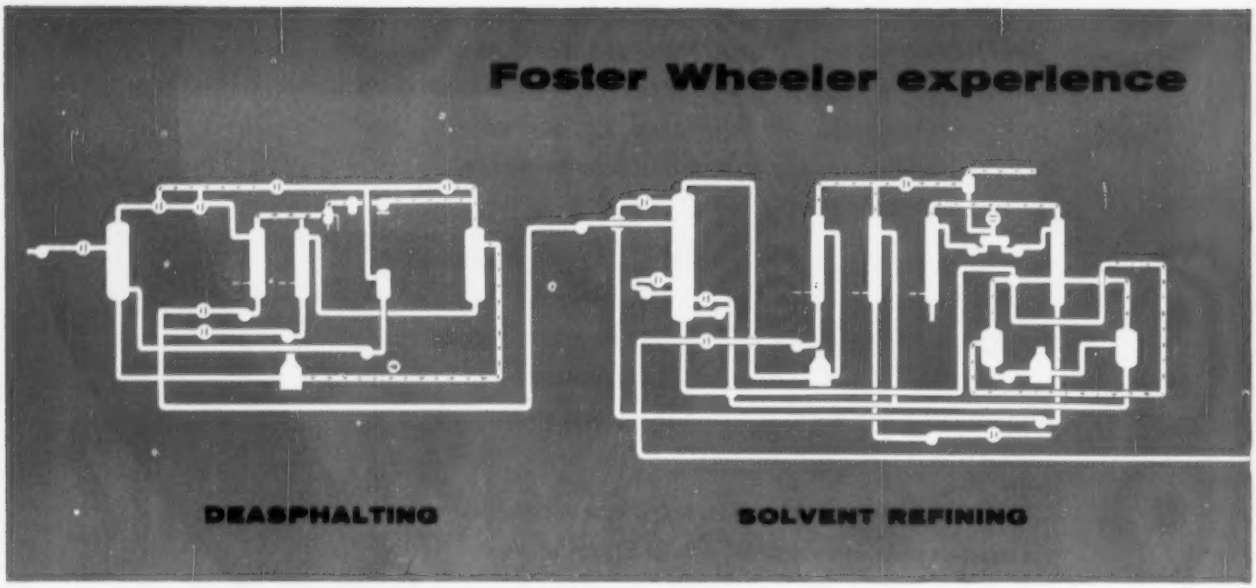
Zallea *expansion joints*

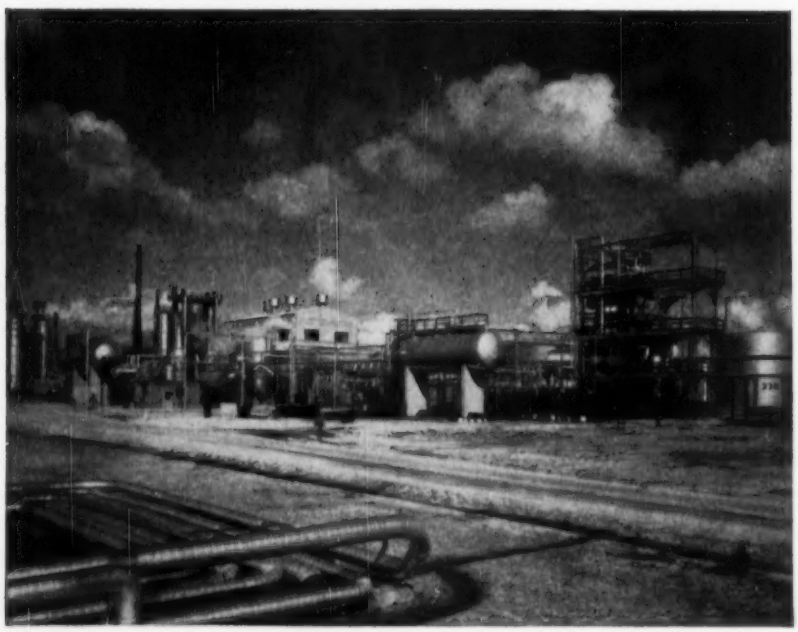
ZALLEA BROTHERS, 890 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints

For more data on advertised products, use Readers' Service Cards, last page.

lube

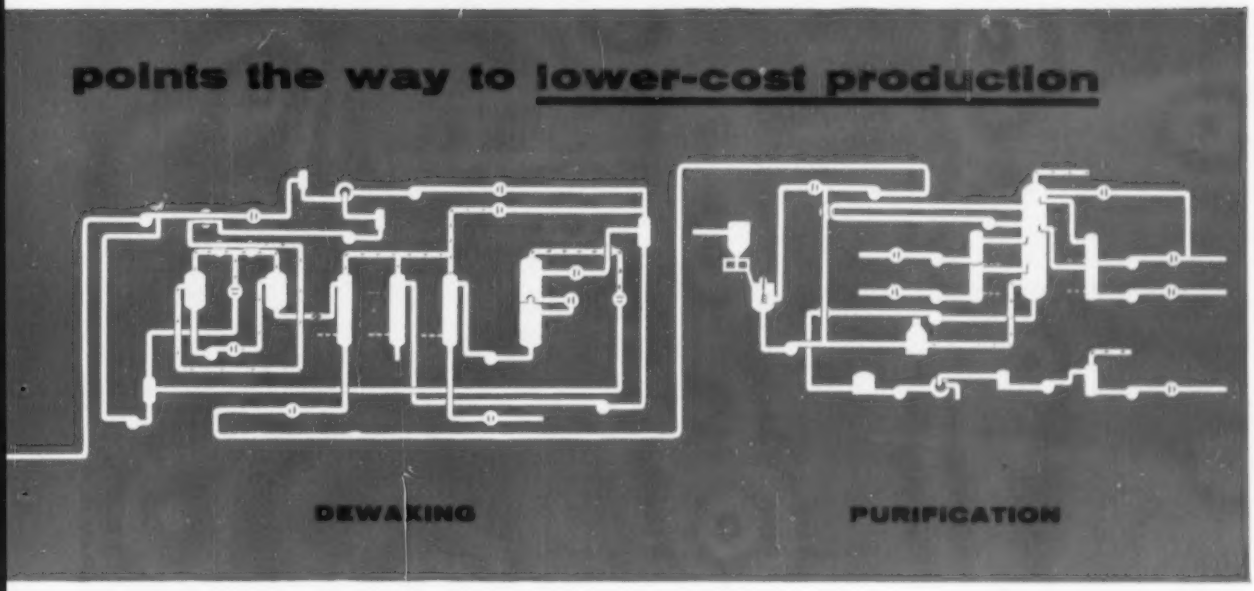




Complete lube oil plant, designed and constructed by Foster Wheeler at England's largest refinery. Process units, in sequence from right to left, are as follows: propane deasphalting, phenol extraction, propane dewaxing and clay contact-vacuum rerun. Foster Wheeler is now building complete lube plants in the United States and Iraq.

oils

points the way to lower-cost production



NEW ADVANCES in refining processes and equipment have resulted in substantial increases in the overall efficiency of lubricating oil production—contributing to higher sustained output of high quality oils at lower unit production cost.

In the construction of new lube oil plants or modernization of existing facilities, Foster Wheeler's long experience in this specialized field is your best assurance of complete satisfaction, from initial planning to final installation and on-stream service. Foster Wheeler process design engineers offer more than 20 years of continuous and cumulative experience in lube oil manufacture. Their intimate knowledge of all phases of design, engineering and construction—plus their close relationship with all licensor companies—can save time, effort and expense in any expansion or modernization program. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

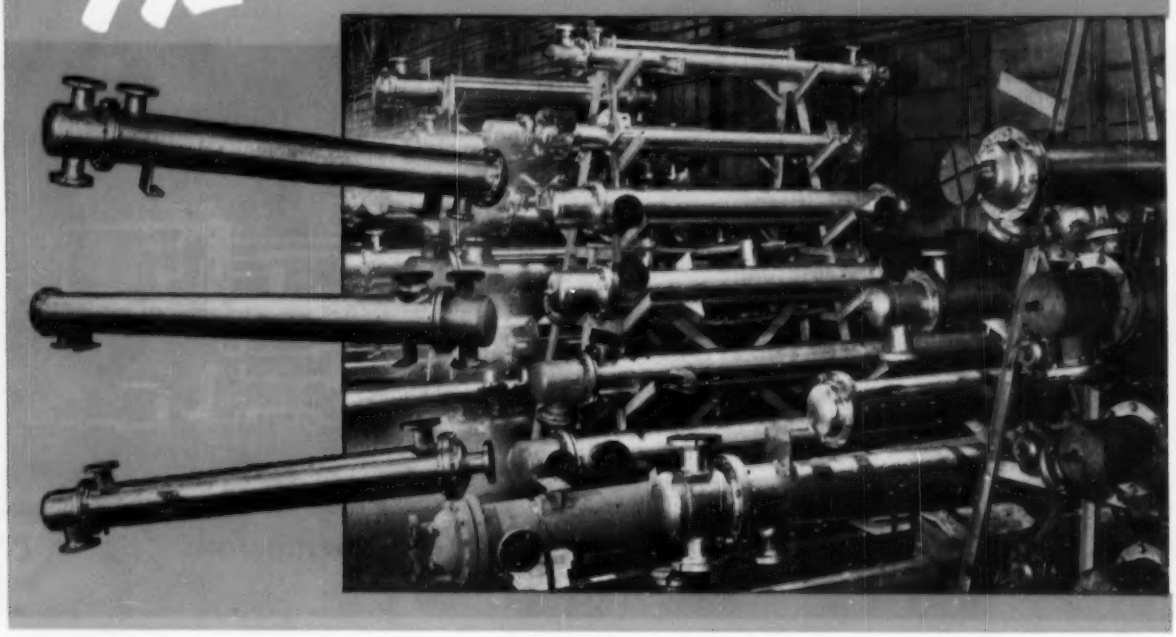
FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

For more data on advertised products, use Readers' Service Cards, last page.

Struthers Wells

Standard HEAT EXCHANGERS



Struthers Wells now offers a line of Standard heat exchangers—in sizes from 20 to 400 square feet of surface—including fixed tube sheet, floating head and U-tube units. Condensers, coolers, heaters and reboilers can be supplied in single and multipass tube arrangements.

Standard heat exchanger construction includes materials of carbon steel, non-ferrous alloy, and stainless alloys Type 304 and Type 316. Equipment meets highest construction standards, including ASME Code and TEMA Class A.

Typical units are illustrated above, including a partial view of those in stock, ready for immediate shipment. Standardization of design and quantity manufacture enables us to offer this equipment at very reasonable cost.

STRUTHERS WELLS PRODUCTS

PROCESSING EQUIPMENT DIVISION

Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

BOILER DIVISION

BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

FORGE DIVISION

Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

MACHINERY DIVISION

MACHINERY for Sheet and Structural Metal Forming . . . Tangent Benders . . . Folding Machines . . . Roller Table and Tumble Die Bending Machines . . . Press Brakes . . . Punching and Notching Machines . . . Forming Dies

Any Size Available for Quick Delivery!

STRUTHERS WELLS *Corporation*

Struthers Wells

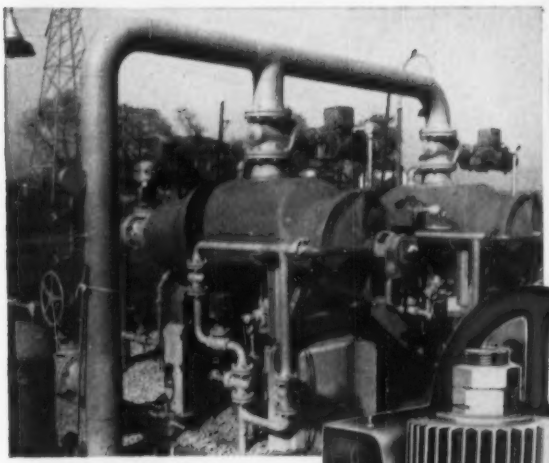
WARREN, PA.

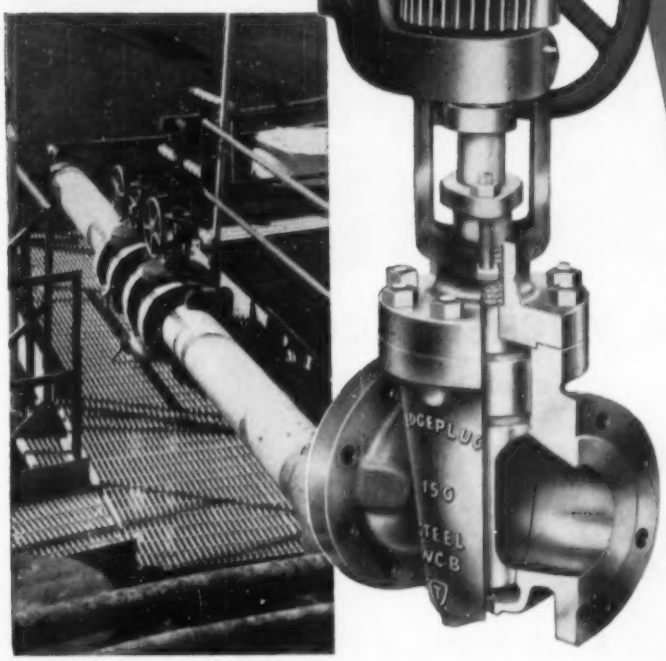
Plants at Warren, Pa. and Titusville, Pa.

Offices in Principal Cities

GENERAL SERVICE

SPECIAL SERVICE





WEDGEPLUG NON-LUBRICATED STEEL PLUG VALVES

The Wedgeplug Principle — by which the non-lubricated plug lifts, turns and re-seats in one operation — assures dependable, trouble-free performance under wide range of temperatures and pressures. Can be furnished wrench-operated, gear-operated, equipped for remote control, or steam jacketed for handling viscous liquids.

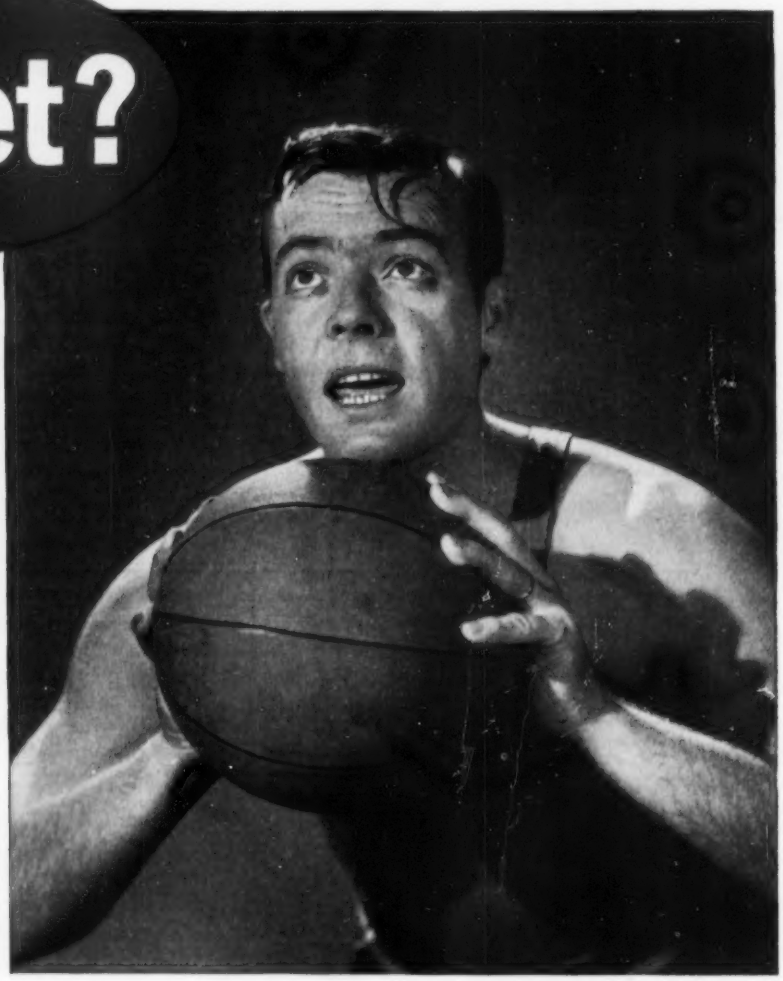
Write for Wedgeplug Catalog No. 55-1-W

WEDGEPLUG VALVE COMPANY, INC.
NEW ORLEANS 25, LA.
An Affiliate of
STOCKHAM VALVES & FITTINGS
GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALA.

For more data on advertised products, use Readers' Service Cards, last page.

Technical foul, tied score and a few seconds to go! That calls for a specialist . . . same as with high-pressure and high-temperature piping. Many leading power and processing plants prove again and again the wisdom of segregating this highly critical type of construction and calling upon the specialized experience of the Mitchell organization.

Basket?



WESTPORT JOINT
(PATENTED)

W. K. MITCHELL & CO., INC.
Philadelphia 46, Pa.

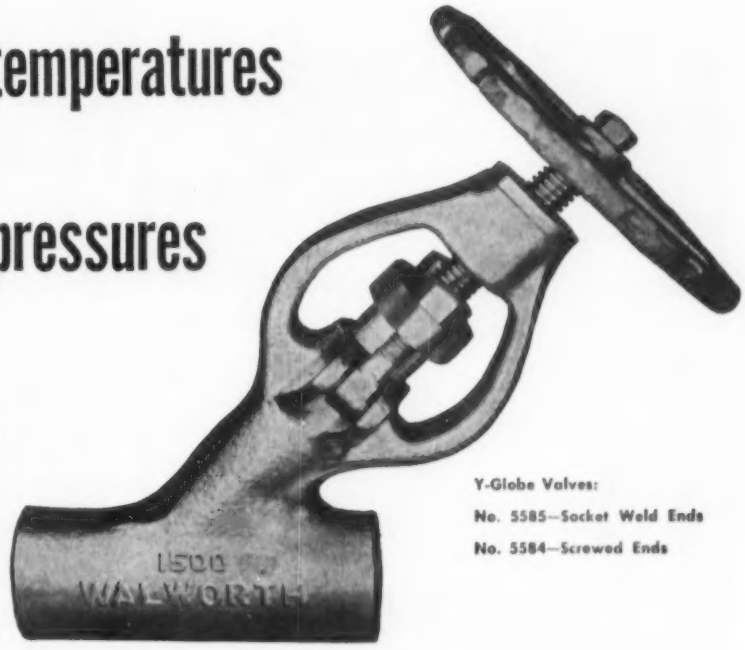
MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS

Walworth's NEW small cast steel valves

SERIES 1500 – SIZES ¼ to 2 inches

handle HIGH temperatures
HIGH pressures



Y-Globe Valves:
No. 5585—Socket Weld Ends
No. 5584—Screwed Ends

Walworth is proud to make these new Small Cast Steel Valves available to power stations . . . oil refineries . . . ships . . . wherever piping is subject to severe pressures and temperatures. Non-shock service ratings of these valves: 1500 psi–950F for steam; 3600 psi–100F for water, oil or gas. Cast of chromium molybdenum steel, they are compact and light, yet exceptionally strong. Both Y-Globe and Angle type valves are available.

Angle Valves:
No. 5587—
Socket Weld End
No. 5586—
Screwed End

Simplified Walworth design eliminates many of the valve problems encountered in high pressure service. Among the features of this new valve are:

INTEGRAL BODY AND YOKE – made from a single casting without threading or welding. Bonnet joint — always a potential source of leakage — is eliminated. Valves can be reassembled quickly and easily.

ROTATING DISC – prevents valve seat distortion and consequent leakage. Cuts down replacements.

WELDED SEAT RING – compensates for changes in pressure and temperature—eliminates a major source of leakage.

SPECIAL BACK SEAT BUSHING – permits repacking the valve under pressure with greater safety.

PACKING CHAMBER – designed to dissipate heat thus keeping packing rings at lower temperatures—gives them longer life.

These valves are available with either socket weld ends or screwed ends, in sizes ranging from ¼ to 2 inches. For further information on Walworth series 1500 Small Cast Steel Valves, see your local Walworth distributor, or write for Circular No. 134.

WALWORTH

valves • fittings • pipe wrenches

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

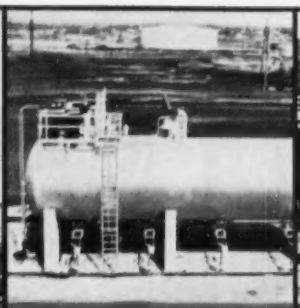
For more data on advertised products, use Readers' Service Cards, last page.

LEADERSHIP

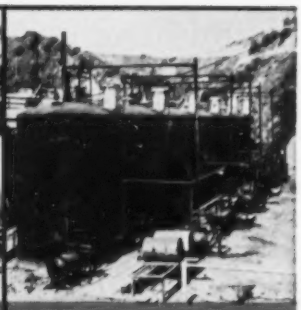
Petreco leadership in electric processing is based on a long series of "firsts"

FIRST Electric Dehydrator

FIRST Closed Dehydrator

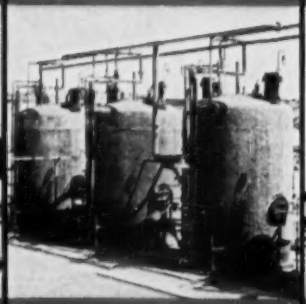


FIRST Horizontal Electric Treating Unit

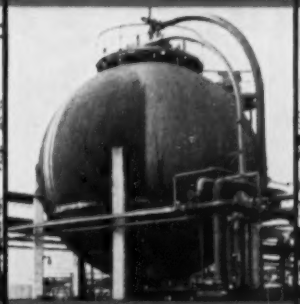


FIRST Pressurized Dehydrator

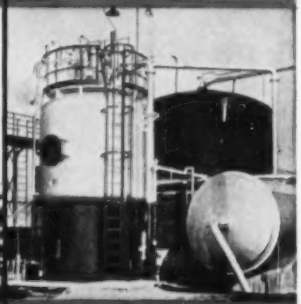
FIRST Flow line Dehydrator



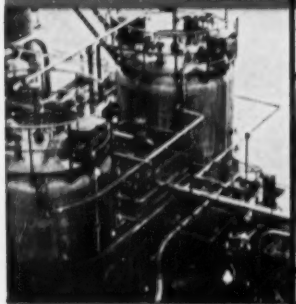
FIRST Electric Desalter



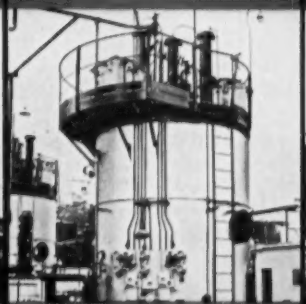
FIRST Spherical Desalter



FIRST Electric Distillate Treater

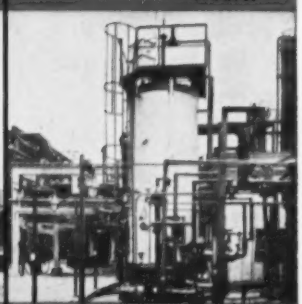


FIRST Electric Desapositier



FIRST Electric Lube Oil Treater

FIRST Electric Sediment Separator



FIRST Two-stage Electric Distillate Treater

This foundation of progressive pioneering has enabled Petreco to help various branches of the industry increase both efficiency and profits. When emulsification threatened to cause the waste of millions of barrels of "cut" oil, Petreco brought out the first electric dehydrator. When salt was first recognized as an enemy in refining, Petreco developed the first electric desalter. When sediment in certain crude oils shortened the life of sub-surface pumping equipment, Petreco developed the electric sediment separator. As refinery processing became more precise, Petreco provided electric distillate treating to insure precision-controlled contacting, scrubbing and washing.

There is one basic and important reason why Petreco has been able to carry on this continuing program of pioneering development — the users of Petreco processing have profited substantially from this use.

For complete information on any of the Petreco electric processes, write or call

PETRECO

A DIVISION OF
PETROLITE CORPORATION
3202 South Wayside Drive, Houston 1, Texas
1390 East Burnett Street, Long Beach 6, California

PETRECO®

AP-8

For more data on advertised products, use Readers' Service Cards, last page.

BENEFITS You can get with SULFAN® (Stabilized Sulfuric Anhydride) for Sulfonated Lube Oil Additives

and other

Emulsifying and Demulsifying Agents

BENEFIT No. 1 **Increase Yields**

Because of the extremely reactive nature of SULFAN, higher molecular weight compounds can be sulfonated to produce desirable oil soluble sulfonates. Treatment with Sulfuric Acid or 20% Oleum leaves these compounds unreacted.

BENEFIT No. 2 **Eliminate Waste Acid Problem**

Since water is not formed when SULFAN is used for sulfonation, the waste acid problem inherent in using Sulfuric Acid or Oleum is eliminated.

BENEFIT No. 3 **Improve Sulfonation Efficiency**

SULFAN has 99.5% SO_3 available for sulfonation reactions; thus, for many applications SULFAN offers nine times as much usable SO_3 as 100% Sulfuric Acid and over three times as much as 20% Oleum. This can mean a considerable saving in sulfonation costs.

BENEFIT No. 4 **Step Up Processing Efficiency**

The absence of waste acid when using SULFAN permits larger batch sizes or more rapid through-put in a sulfonation process. This means that by using SULFAN, batch size or through-put can be doubled or tripled without increasing the size of the equipment.

Tank Car Quantities

A laboratory development just a few short years ago, SULFAN today is a commercial chemical of ever-growing importance. This new processing tool is now being regularly shipped to many users in tank car quantities. For technical data on SULFAN, experimental quantities, or other assistance, contact any General Chemical office listed below.

Basic Chemicals For American Industry

Allied Chemical

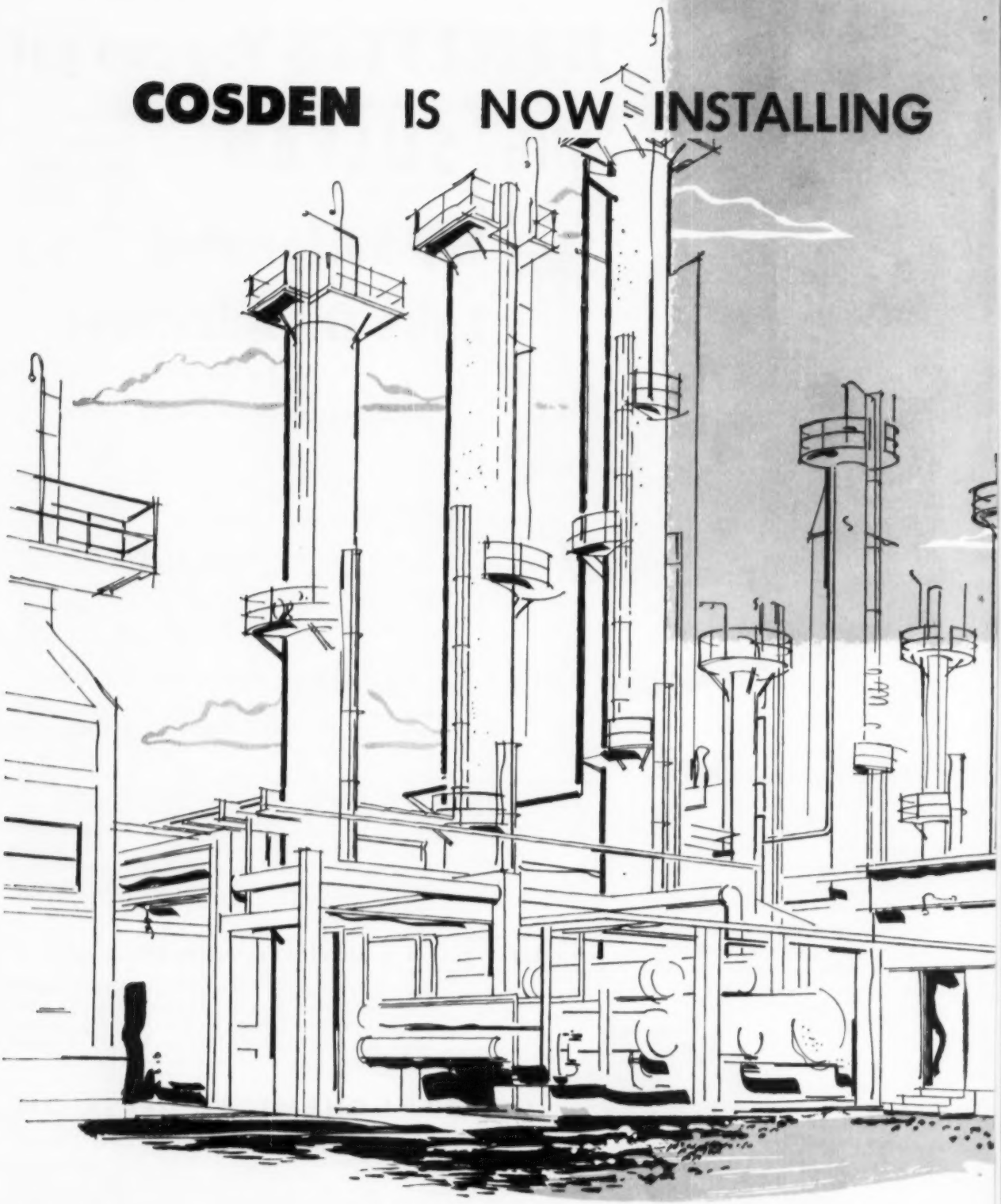
GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo Charlotte • Chicago • Cleveland • Denver • Detroit • Greenville (Miss.) • Houston Jacksonville • Kalamazoo • Los Angeles • Milwaukee • Minneapolis • New York • Philadelphia Pittsburgh • Providence • San Francisco • Seattle • St. Louis • Yakima (Wash.)

In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

For more data on advertised products, use Readers' Service Cards, last page.

COSDEN IS NOW INSTALLING



Rexforming

TRADE MARK

Always among the leaders in the production of highest quality petroleum products and petrochemicals, Cosden Petroleum Corporation is installing the UOP Rexforming process to keep pace with the growing requirements for better motor fuels.

The Rexforming process, capable of producing gasolines having octane ratings well in excess of 100, will enable Cosden to use its UOP Platforming unit, which now produces gasoline blending material, for continuous preparation of aromatic feed stock for a Udex unit.

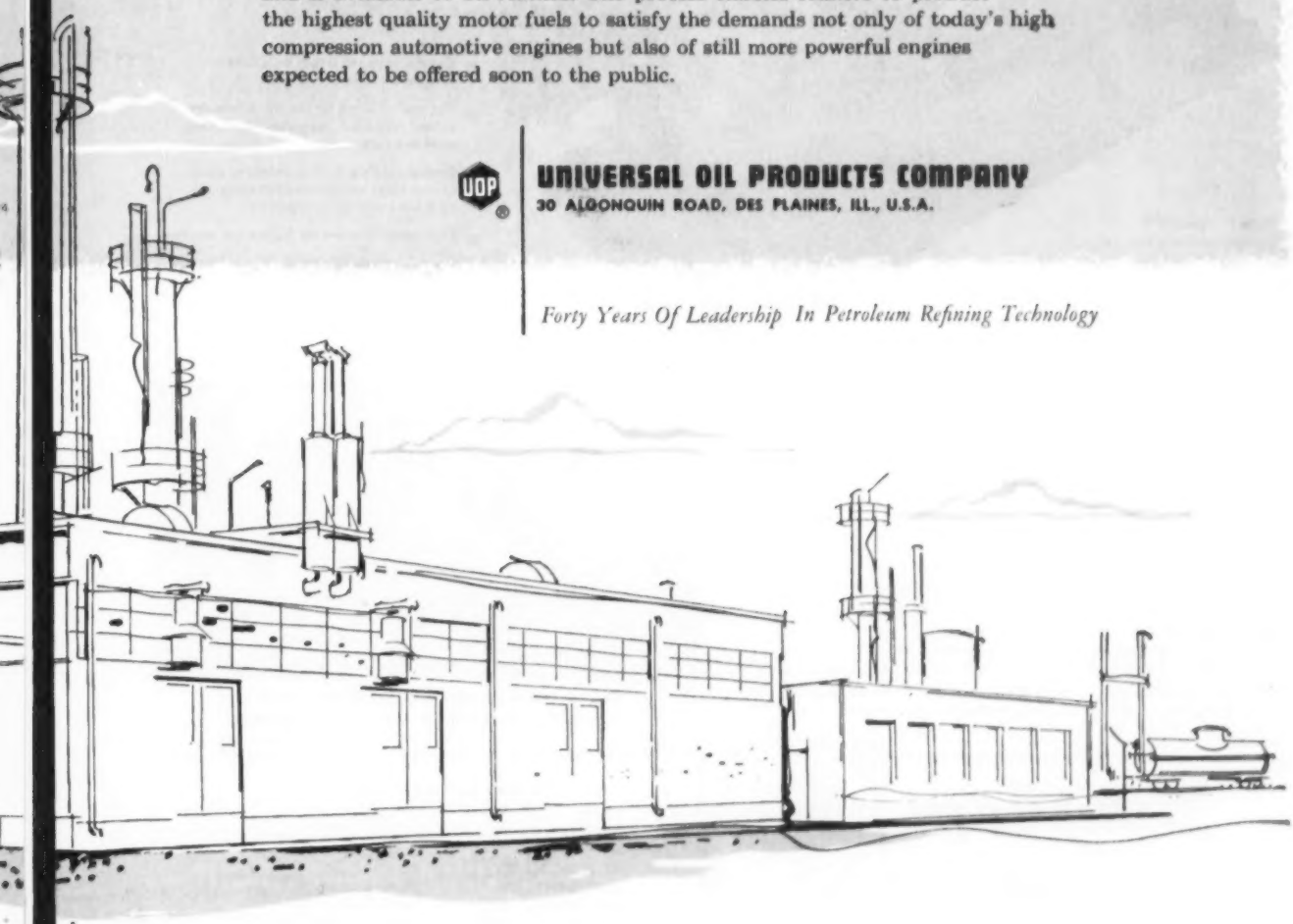
Rexforming, the latest catalytic reforming process, was developed by Universal and is available to all refiners. The process enables refiners to produce the highest quality motor fuels to satisfy the demands not only of today's high compression automotive engines but also of still more powerful engines expected to be offered soon to the public.

UOP

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILL., U.S.A.

Forty Years Of Leadership In Petroleum Refining Technology



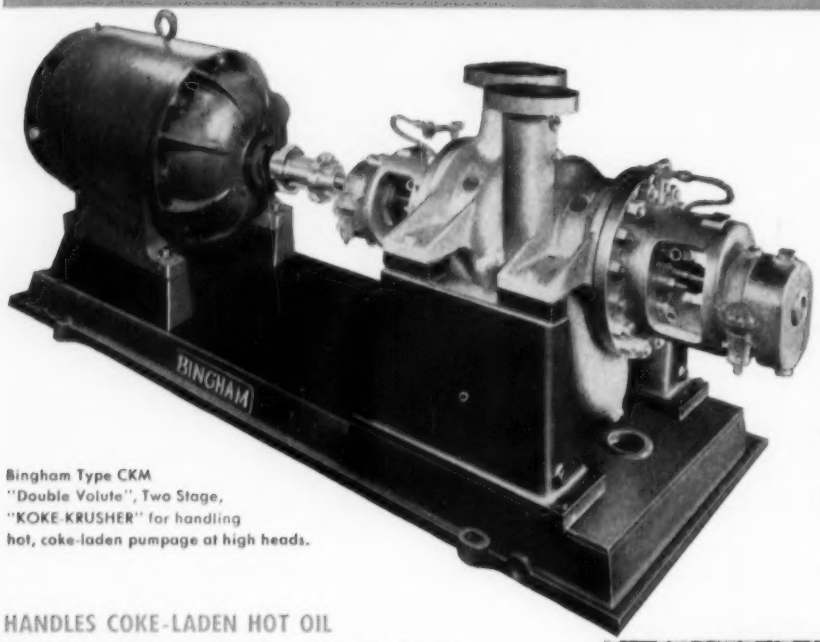
For more data on advertised products, use Readers' Service Cards, last page.

Bingham

"KOKE-KRUSHER" HOT OIL PUMP

NON-CLOGGING!

PULVERIZES LARGE PIECES OF ENTRAINED COKE IN PUMPAGE



Bingham Type CKM
"Double Volute", Two Stage,
"KOKE-KRUSHER" for handling
hot, coke-laden pumpage at high heads.

CRUSHES COKE INSTANTLY
Positive crushing mechanism instantly crushes large pieces of hard coke entrained with the pumpage.

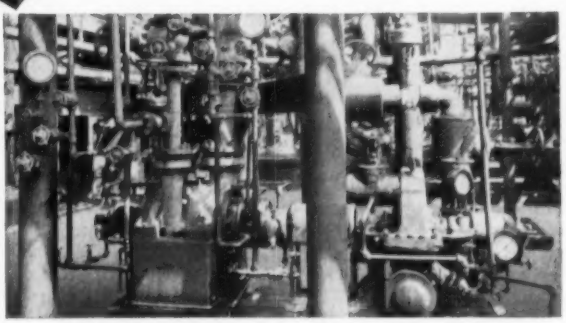
- Results in more hours on stream—less down time.
- The pulverizing action on entrained solids reduces clogging of other system equipment.
- Non-pulsating flow eliminates need of auxiliary equipment for control of pressure and/or capacity.
- Eliminates expensive protective devices.
- Smooth pump characteristics eliminate destructive vibration.
- Lower maintenance. Only one moving part.

HANDLES COKE-LADEN HOT OIL IN CRACKING SYSTEMS WITHOUT CLOGGING

The Bingham "Koke-Krusher", the only pump that crushes coke, is a field-proven, centrifugal pump specially designed for the severe services of pumping oil products such as *Residuum, Flash Tower Bottoms, Black Oil Recycle*—in which the oil carries in suspension pieces of hard coke of irregular size and shape.

This revolutionary Bingham pump features a coke crushing mechanism located in the suction chamber immediately in front of the impeller eye. Any piece of solid coke entrained in the pumpage *must* pass through the crusher, where it is instantly pulverized, before entering the impeller.

The resulting pulverized coke particles are small enough to assure free flow through the pump and all system equipment. The Bingham "Koke-Krusher" will make a big difference in your operations. Call your nearest Bingham office for full details.



Bingham "Koke-Krusher" pumping flash tar bottoms in pressure coke still of a large midwest refinery.

Bingham SINCE 1921 — DOUBLE VOLUTE PUMPS — RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B.C., Canada**

SALES AND SERVICE OFFICES

BOSTON, MASS.	PITTSBURGH, PA.
CHICAGO, ILL.	SAN FRANCISCO, CALIF.
DENVER, COLO.	SEATTLE, WASH.
HOUSTON, TEXAS	ST. LOUIS, MO.
KANSAS CITY, MO.	ST. PAUL, MINN.
NEW ORLEANS, LA.	TULSA, OKLA.
NEW YORK CITY, N.Y.	TORONTO, ONT., CAN.
PHILADELPHIA, PA.	VANCOUVER, B.C., CAN.

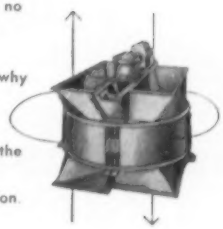
reduce slag

stay on stream at top capacity months longer with the Ljungstrom® Air Preheater

HOW FAST IS "WRITE OFF"?

By cutting turnaround time alone, the Ljungstrom means major savings for you. When you take the other Ljungstrom advantages into account—up to 20% fuel saving . . . more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . consistently higher through-put . . . higher product quality—you can see why a Ljungstrom is paid out in just a few months.

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits attainable in fuel burning equipment—call or write The Air Preheater Corporation.



Wherever You Burn Fuel, You Need Ljungstrom

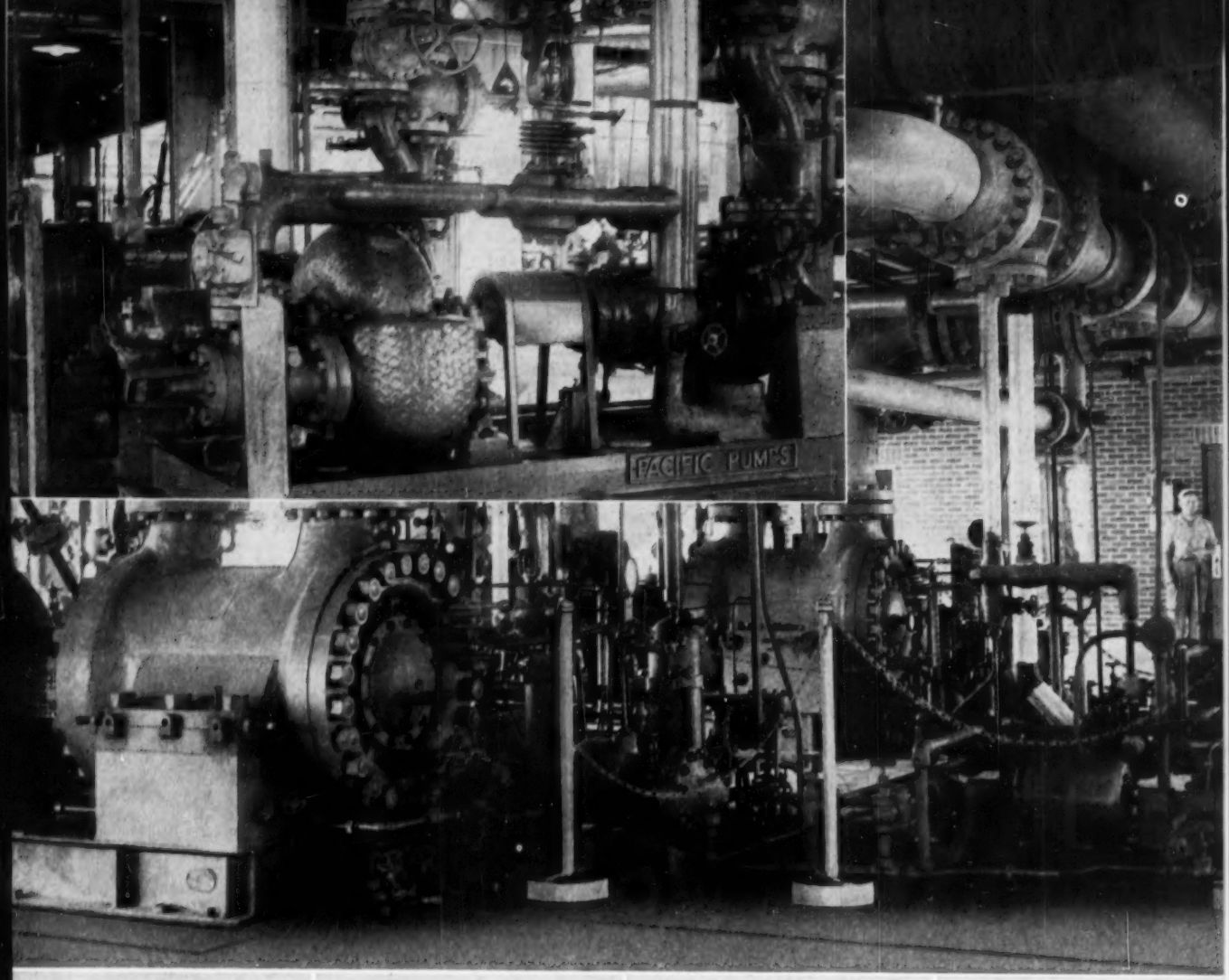
The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

Slag—primary cause of reduced capacity—can be substantially reduced by the Ljungstrom Air Preheater.

That's because preheated air mixes more thoroughly with fuel. The result is better combustion . . . and less slag-forming material present in the furnace. Oil tubes stay cleaner . . . stills stay on stream at top capacity for months longer. As an example, one pipe still in an eastern refinery dropped from 16,000 barrels a day to 12,000 because of slag. Now, with a Ljungstrom and modern high-temperature burners, the still operates continuously at 18,000/20,000 barrels.

The Air Preheater Corporation **60 East 42nd Street, New York 17, N. Y.**

For more data on advertised products, use Readers' Service Cards, last page.



IDECO

IDECO, Dallas, Tex.—Hydrair and Power Rigs; Full-View Masts; Substructures; Single, Dual and Drive-In Rambler Rigs; Blocks, Swivels, Rotaries; Mud Pumps; Petroleum Equipment and Supplies.

Magcobar.

MAGNET COVE BARIUM CORP., Houston, Tex.—Magcobar and Magcogel drilling muds and other specialized oil well drilling fluids and chemicals.

Security

SECURITY ENGINEERING DIVISION, Dallas, Tex., Whittier, Calif. — Rock bits, reamer rock bits and hole openers; reamers, casing scrapers and Neo-Red rubber stabilizers.

PACIFIC

PACIFIC PUMPS, INC., Huntington Park, Calif. — Centrifugal pumps for refineries, power stations, pipelines, and chemical plants; plunger pumps for oilwells.

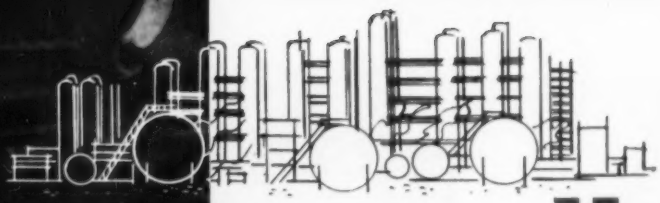
compressors for every application

CLARK®

Clark Bros. Co. is the country's leading manufacturer of heavy duty compressors and turbo machinery for the petroleum, gas, process and general industry.

Clark builds a complete line of centrifugal compressors in the 1,000 – 100,000 CFM capacity range. Pressures in excess of 2,500 psi can be readily handled. Gas turbines in the 8,500 BHP class and Mobile power plants in the 5,500 – 6,500 KW capacity are also built by Clark as are axial flow compressors and recovery turbines.

A complete line of reciprocating compressors in gas, steam, diesel and electric motor driven types are available in the 75 – 4,500 BHP range. Included in the line are the world's first 2-cycle turbo-supercharged gas-engine-driven compressors. Clark builds a compressor to fit practically any heavy duty application.



How the DRESSER *plus* + works...

Throughout the petroleum and petrochemical industries, products of Dresser companies are teamed together to help produce and process the fuels and chemicals so vital to the modern world.

For instance, at Shell Oil Company's Deer Park, Texas refinery, Clark barrel type centrifugal compressors handling hydrogen at high pressure on a reforming application team up with Pacific process pumps. The Clark units, shown in the large illustration, are the first of their type placed in service.

Handling hydrogen at pressures approaching 1,000 psi calls for compressors that are the ultimate in design, material and workmanship. The fact that 75% of all reforming plants of this type use Clark barrel type centrifugal compressors speaks for itself.

At the upper left, the Pacific pumps are shown in operation moving thousands of gallons of process stock daily.

In this Clark-Pacific equipment team operators gain the experience, engineering, research and development facilities and resources of all the Dresser companies.

This in turn results in equipment that is modern in design and unequalled in performance, dependability and long life. You get the Dresser Plus + by specifying Dresser products and equipment . . . the standard of comparison the world over.

ROOTS-CONNERSVILLE BLOWER DIVISION, Connersville, Ind.—Rotary positive blowers, gas pumps, centrifugal blowers, exhausters, and positive displacement meters.

LANE-WELLS CO., Los Angeles, Calif., Houston, Tex., Oklahoma City, Okla.—Electric and Radioactivity Well Logging, Koneshot perforating and bullet perforating, packers and bridging plugs.

DRESSER-IDECO DIVISION, Columbus, Ohio—Radio and television broadcasting towers, steel buildings, aircraft hangars, mechanical parking garages, electric power substations.

DRESSER MANUFACTURING DIVISION, Bradford, Pa.—Pipe line couplings, pipe repair sleeves and clamps, weldments, forgings, welding fittings, flanges, rings.

DRESSER INDUSTRIES, INC.

OIL, GAS, CHEMICAL AND ELECTRONIC EQUIPMENT AND SERVICES

REPUBLIC NATIONAL BANK BUILDING • POST OFFICE BOX 718 • DALLAS 21, TEXAS

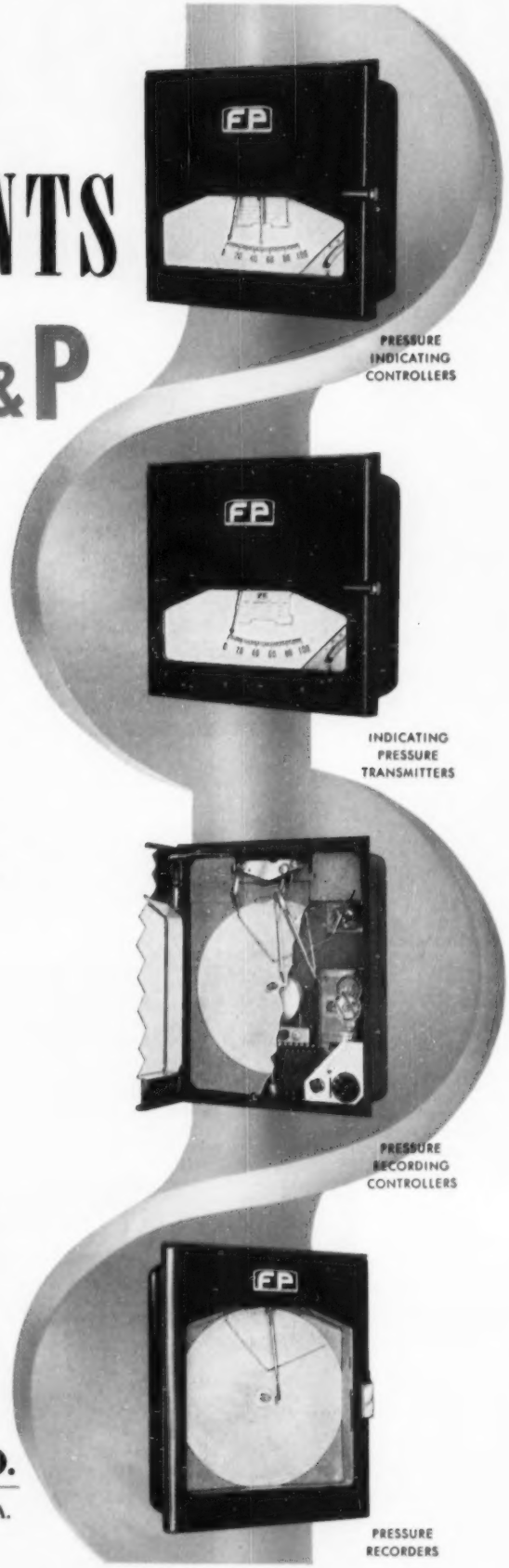
get PRESSURE INSTRUMENTS FAST from F&P

Fischer & Porter now proudly offers a complete line of pressure instruments for one week shipment from stock. These accurate pressure instruments may be used to measure vacuum pressure or gauge pressure from absolute zero to 1,000 psig.

The pressure elements are available in brass, 316 stainless steel, phosphor bronze and beryllium copper. Guaranteed accuracy of all instruments is 1% of full scale, with positive over-range and under-range protection built into each instrument. Recorders, recording controllers, indicators, indicating controllers and pneumatic transmitters are available for one week shipment.

But why wait until an emergency demands fast delivery? Why not get to know the entire F&P instrument line better, now? A word from you will bring completely detailed information without obligation.

Fischer & Porter is in the instrument business to assist you. Doing it expertly and well has helped F&P grow. Get to know F&P better, call on F&P for a single instrument or a complete process instrumentation system.



FP FISCHER & PORTER CO.

926 COUNTY LINE ROAD, HATBORO, PENNA.

Report.....on CHEMICO

Sludge Acid Regeneration Plants

CONSOLIDATED CHEMICAL INDUSTRIES

Division of Stauffer Chemical Company
640 NELLIE ESPERSON BUILDING
HOUSTON 2, TEXAS

December 7, 1955

AIR MAIL

Mr. J. H. Ruskin
Executive Vice President
Chemical Construction Corporation
525 West 43rd Street
New York 36, New York

Dear Mr. Ruskin:

I want to tell you that we are very much pleased with the manner in which our Baytown and Houston, Texas, Sulfuric Acid Regeneration Plants are performing.

We think that your organization applied itself most diligently and efficiently to the design and construction of these two plants.

We mean sincerely the things we are stating in this letter and we trust that you and your organization will continue to prosper and we look forward to having you do engineering and construction work for us in the future.

Very truly yours,

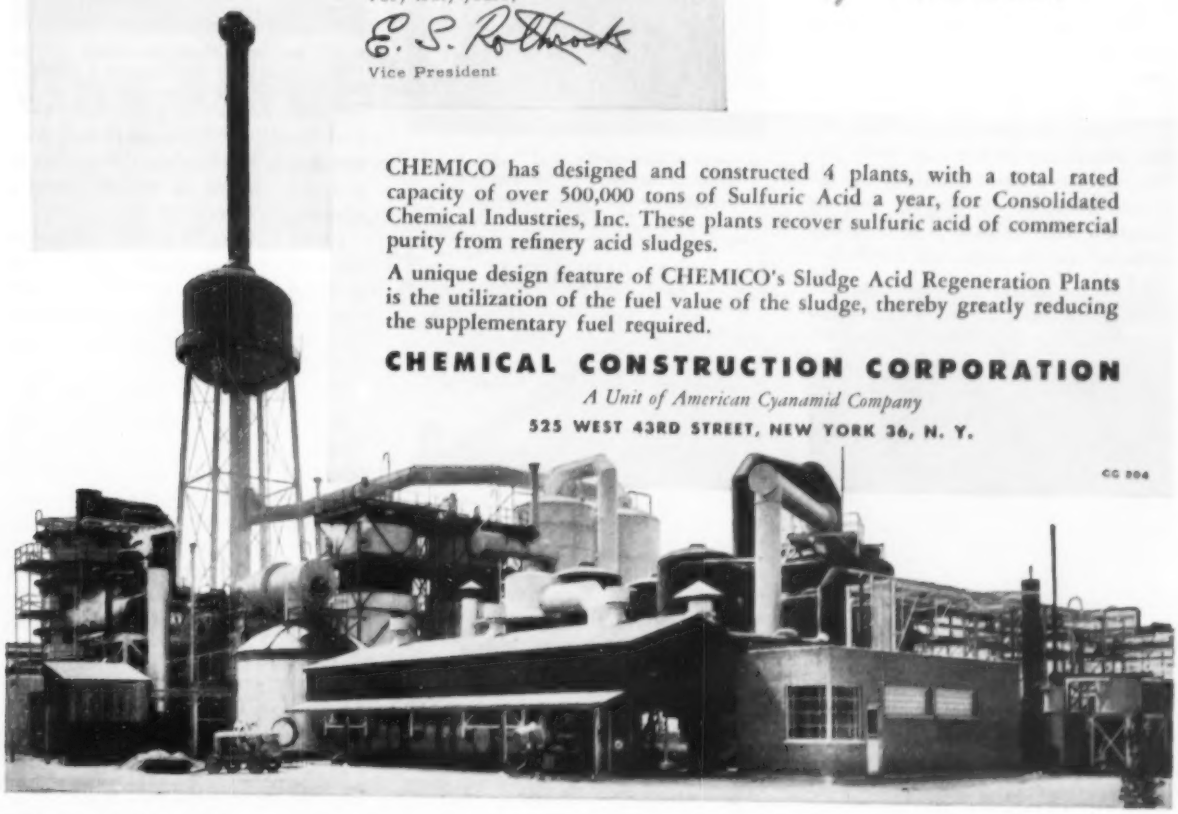
E. S. Rothrock

Vice President

performance

design and construction

future work by Chemico



CHEMICO has designed and constructed 4 plants, with a total rated capacity of over 500,000 tons of Sulfuric Acid a year, for Consolidated Chemical Industries, Inc. These plants recover sulfuric acid of commercial purity from refinery acid sludges.

A unique design feature of CHEMICO's Sludge Acid Regeneration Plants is the utilization of the fuel value of the sludge, thereby greatly reducing the supplementary fuel required.

CHEMICAL CONSTRUCTION CORPORATION

A Unit of American Cyanamid Company

525 WEST 43RD STREET, NEW YORK 36, N. Y.

CC 204

For more data on advertised products, use Readers' Service Cards, last page.

Corrosioneering News

Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

Published by The Pfaudler Co., Rochester, N.Y.

4 ways to save money

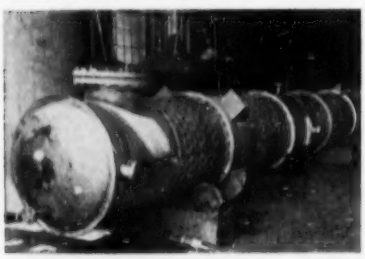
PROCESSING

1. Standard Pfaudler glassed steel kettles (up to 4000 gals.) answer to wide range of corrosive processes.

Now, in low-cost *standard* models up to 4000 gallons, Pfaudler glassed steel reaction kettles resist all acids (except hydrofluoric) and alkaline solutions up to pH 12 and 212° F.

No metallic contamination of product. Maximum processing flexibility. No corrosive destruction of equipment. Structurally strong, too, to handle a wide range of pressures. For detailed specifications, ask for Bulletin 926.

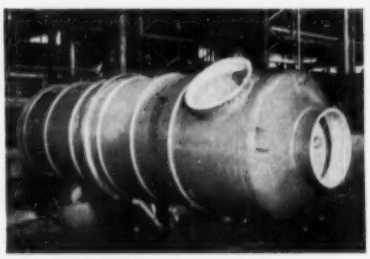
2. High-pressure corrosive operations solved with these Pfaudler columns.



Stainless steel column:
Dimpled jacket adds strength.

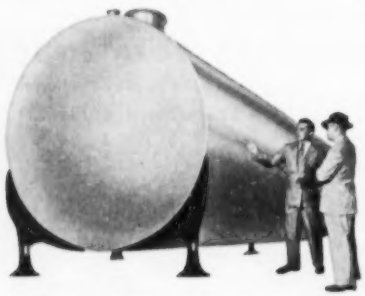
Two types of columns made by Pfaudler give you special advantages for high-pressure work. Stainless steel columns, reinforced by an exclusive dimpling process, greatly increases the strength of the metal but keeps its thickness (and, therefore, its cost) down. Applicable to almost any type of design. Bulletin 907 gives you complete details.

Another new development in corrosion resistance is Pfaudler's glassed steel Turbogrid column with all-glass trays. Design increases capacity up to 100% over other columns of the same dimensions. Resists most acids; also alkalies (up to pH 12 and 212° F.), even at elevated temperatures. Adapts from one process to another. Easy to clean. Ask for Bulletin 933.



Glassed steel column:
All-glass interior resists corrosion—
Turbogrid design increases capacity.

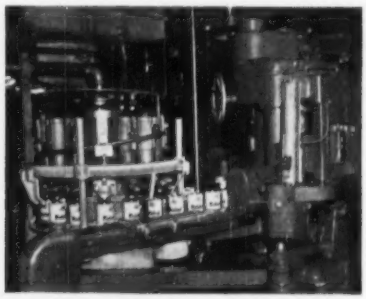
STORAGE



3. Tough glassed steel tanks up to 35,000 gals. Cost as little as 25c per gallon capacity.

Store your product in inexpensive Chemstor tanks – the glassed steel tanks that cost only 25¢ per gallon of capacity, in the larger sizes. Size range: 750 to 35,000 gals. Corrosion resistance of glass, *plus* the working strength of steel, protects your product from contamination. Easy to clean because almost nothing sticks to glass. Ask for Bulletin 918.

FILLING



4. Filling machines package oil at speeds up to 500 quarts a minute —within 1/10 oz. accuracy!

Four models of Pfaudler Rotary Piston Filling Machines are available to give you speeds up to 500 quarts a minute.

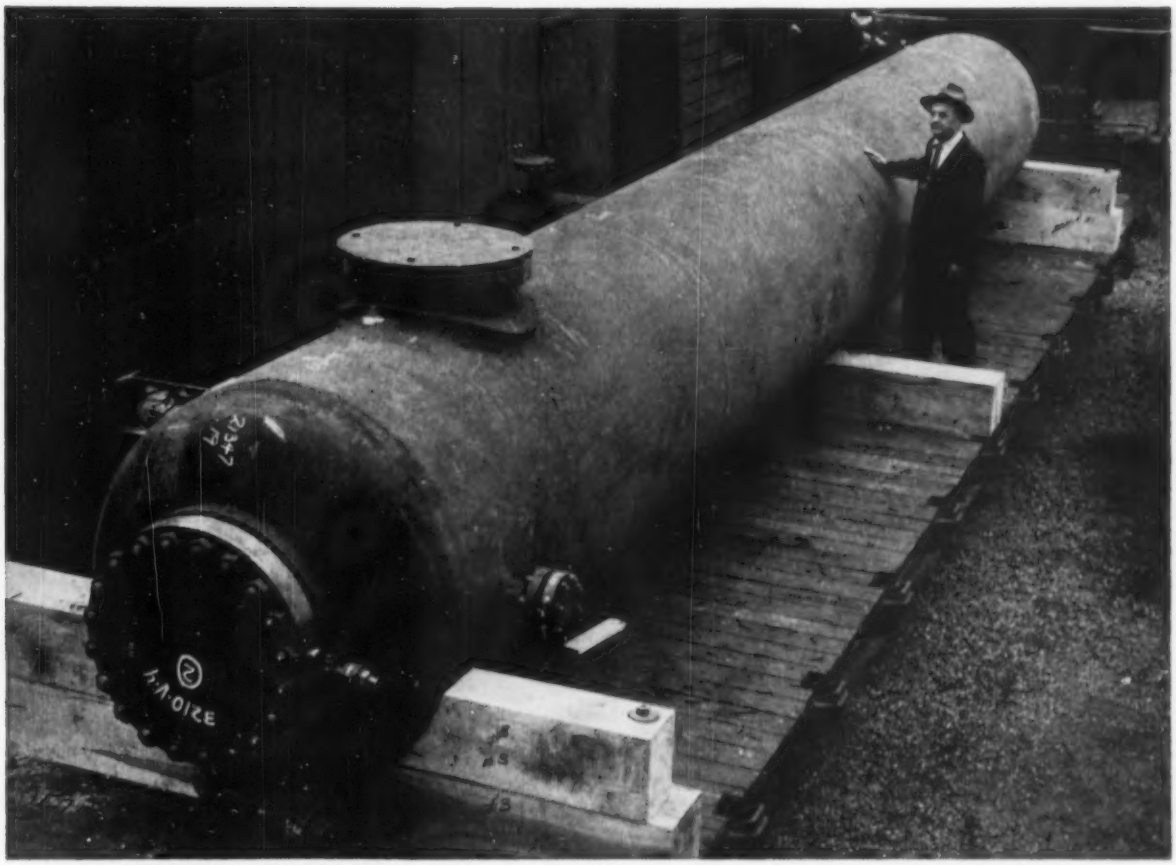
From slowest (6 piston) to fastest (21 piston), these fillers all give you accuracy to within ± 1/10 oz. And you can adjust the fill without stopping the machine, simply by turning a single screw!

You get cleaner filling, too. No-can-no-fill feature prevents mishaps. Single-file straight line discharge prevents the spilling you can get by other discharge systems.

Cleaning is simple. No tools needed. Only two parts to remove from each piston. No piston rings, connecting rods, wrist pins. One man can do clean-up in a few minutes! Bulletin 878.

GET THE FACTS

Write today for full information!
Your answer by return mail!



NEWPORT NEWS BUILT two 39'-7" horizontal gas scrubbers, such as this, for J. F. Pritchard & Co. They were made of ASTM-A212 Grade B fire box steel, with structural mesh steel interiors.

Gas scrubber made of 2⅞" steel

Newport News builds almost any type of pressure vessel and other heavy process equipment

Here is one of two horizontal gas scrubbers recently built for an operating pressure of 1800 psi at 300°F.

Newport News made both vessels from fire box steel, 2⅞ inches in thickness. We formed and automatically welded this steel into sections having a diameter of only 4 feet.

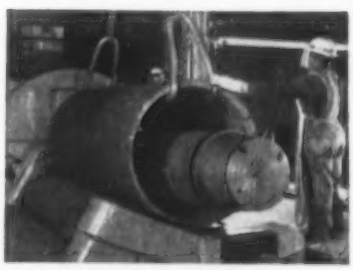
Rolling thick steel to this small diameter...no easy accomplishment, as you probably know . . . demonstrates the sort of jobs Newport News takes in stride.

Almost any type of heavy processing equipment is readily constructed by Newport News in a 225 acre plant comprising huge, fully equipped fabricating and machine shops, foundries, forge and die shops, heat treating and allied equipment as well as complete test facilities.

Newport News shop erection of fabricated units helps to speed assembly at your plant site.

Get a bid from Newport News on your present or future projects. Get the benefit of specialized production techniques. Look over the many ways in which Newport News can help you . . . write for "Facilities and Products", a very interesting booklet. It's yours for the asking.

ENGINEERS Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.



ROLLING 2⅞" STEEL for gas scrubbers. The steel, in a hot condition, was formed on the heavy bending equipment shown here. It will cold roll mild steel up to 3 inches thick, and will hot roll any grade of steel up to a thickness of 5 inches.

Newport News Shipbuilding and Dry Dock Company
Newport News, Virginia

For more data on advertised products, use Readers' Service Cards, last page.

HIGHEST AWARD IN ENGINEERING

IT'S a repeat contract—and no medal or citation could indicate higher approval of McKee services.

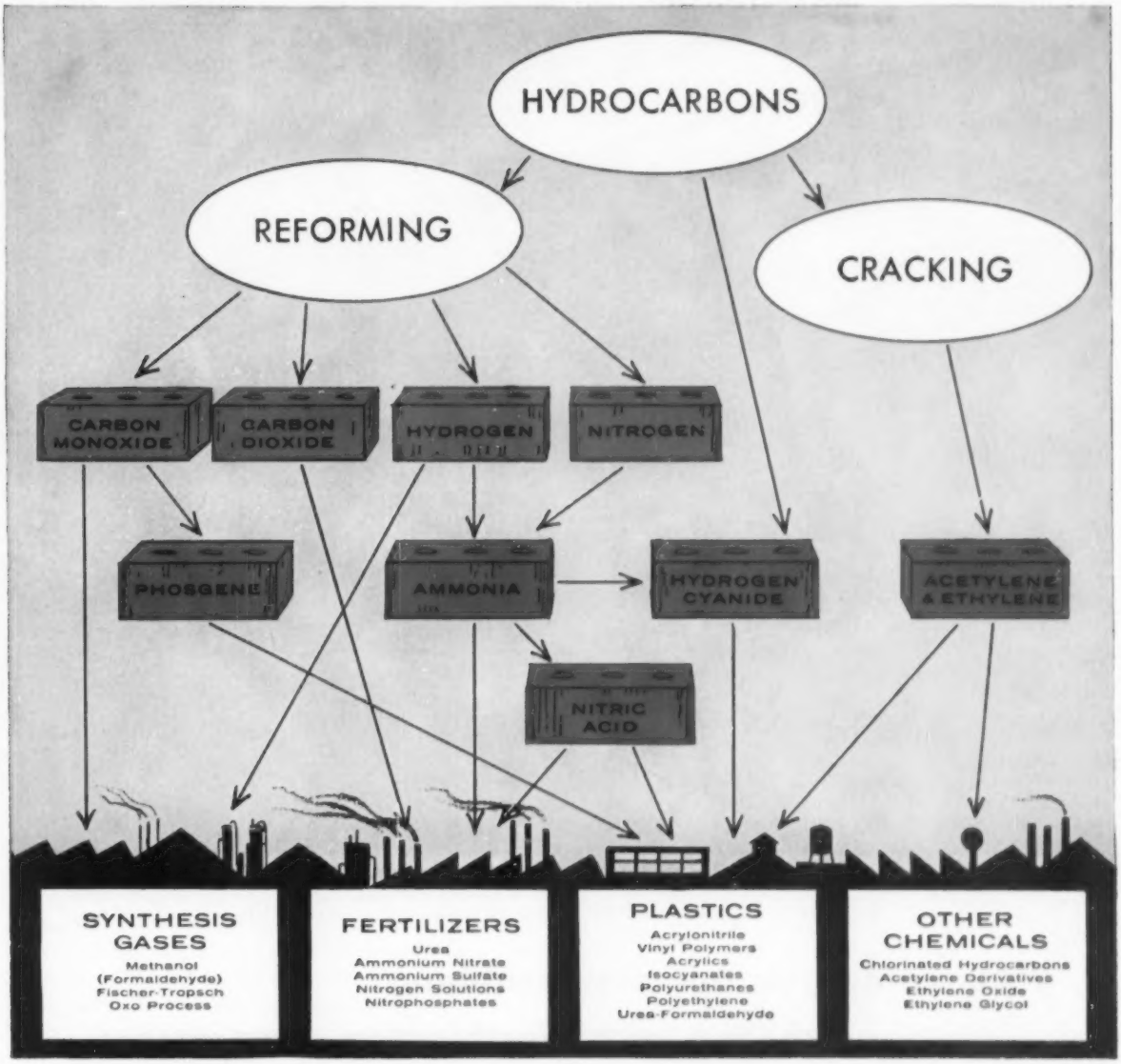
In a half-century of engineering and construction McKee has been awarded over 2600 contracts by discerning businessmen who know what they want and where to get it. More than two-thirds of these were *repeat contracts.*

This willingness of large companies to repeatedly entrust to McKee the expenditure of millions of dollars in plant investment is proof of the value of McKee engineering and construction.

McKee
ENGINEERING & CONSTRUCTION
Services

Arthur G. McKee & Company • Engineers and Contractors

Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York, N. Y. • Union, New Jersey • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto



Building blocks for chemical expansion ...produced with GIRDLER plants

These nine basic intermediates made from hydrocarbons, and some of the end chemicals, are produced with Girdler plants. Here is another indication of Girdler's broad experience available to you for the expansion of your processing facilities.

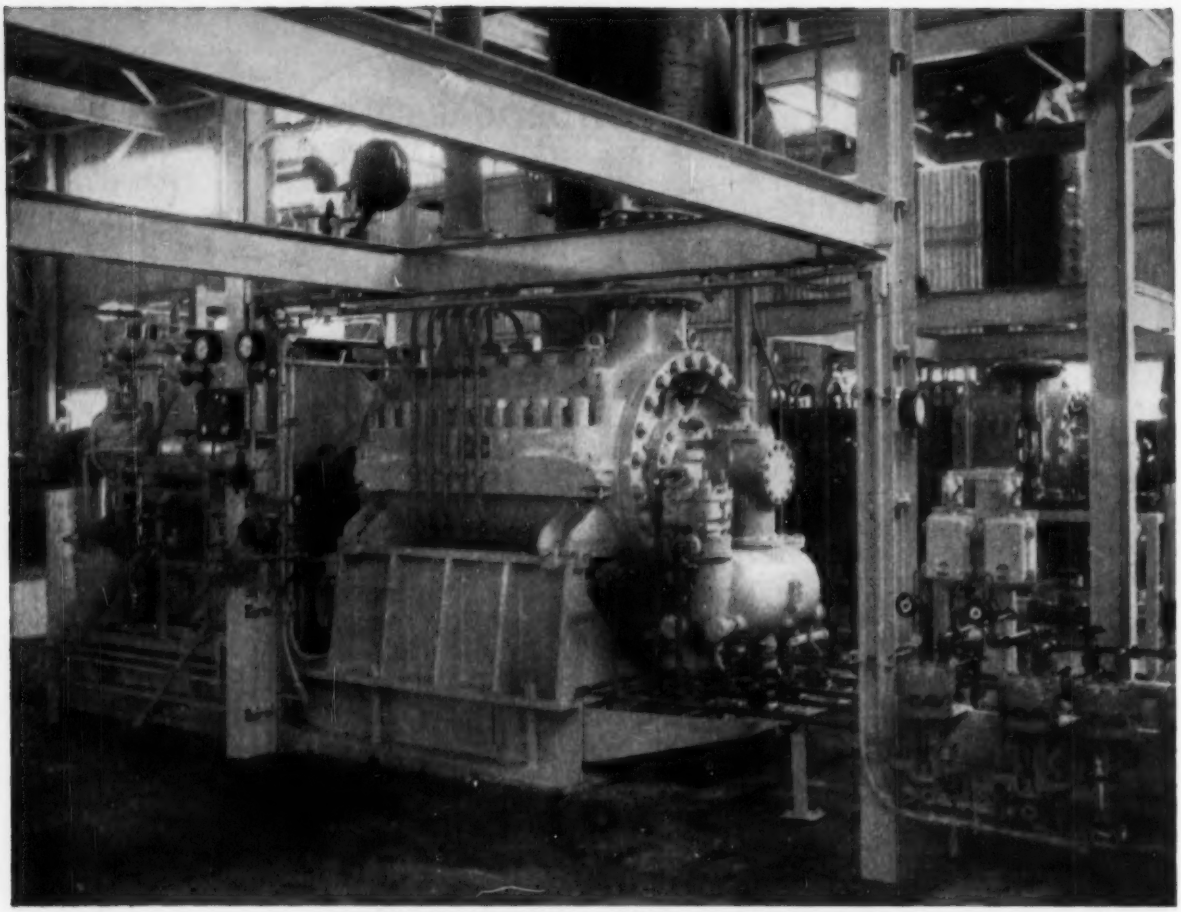
Girdler assumes responsibility for designing, engineering and construction of process plants for these synthesis gases . . . and many other products. Take advantage of Girdler's vast experience when you *start* to plan your processing facilities!

The **GIRDLER** Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY

GAS PROCESSES DIVISION: New York, San Francisco • **VOTATOR DIVISION:** New York, Atlanta, Chicago, San Francisco
In Canada: Girdler Corporation of Canada Limited, Toronto

For more data on advertised products, use Readers' Service Cards, last page.



ONE OF TWO WORTHINGTON CENTRIFUGAL COMPRESSORS keeping the temperature — and cost — *low* in ammonia processing at Lion Oil Company's plant. This unit cools a copper solution used to scrub NH_3; and chill and condense the compressed NH_3 gas to a liquid state.

Ammonia gets low-cost scrubbing and chilling with Worthington compressors

Every day 20 million cubic feet of natural gas are used in producing 300 tons of anhydrous ammonia at Lion Oil Company's Barton Plant in Luling, Louisiana — and nothing goes to waste!

Part of the credit for this efficient operation goes to two new Worthington centrifugal compressors which chill and scrub ammonia gas during the synthetic process. Unlike ordinary compressors, the new Worthington units employ interstage liquid ammonia injection — an exclusive feature that effectively reduces the heat of compression and thereby more efficiently converts velocity energy into pressure.

Choice of the Worthington compressors was based largely on this efficient design which has already introduced new economies into the Barton Plant operation. The centrifugal units, each rated at more than 1300 tons capacity, are powered by reliable Worthington steam turbines.

Worthington centrifugal compressors may be the answer to low-cost, high-volume processing in your plant, too. Find out how these units put big chilling jobs on a more profitable basis by writing Worthington Corporation, Air Conditioning & Refrigeration Division, Section A.5.61-PE, Harrison, N.J. A.5.61

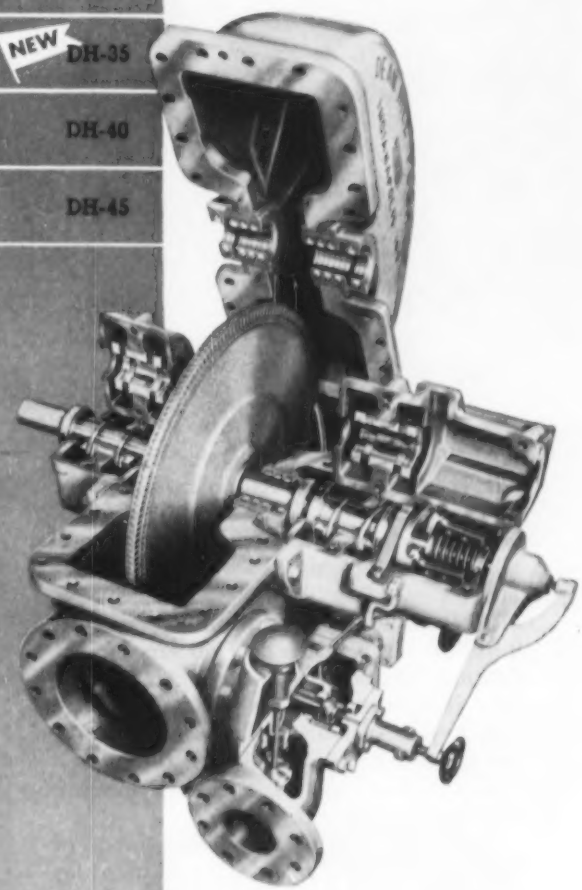
WORTHINGTON

CLIMATE ENGINEERS TO INDUSTRY, BUSINESS AND THE HOME

THREE NEW MODELS

DH-10
NEW DH-15
DH-20
NEW DH-25
DH-30
NEW DH-35
DH-40
DH-45

NOW YOU CAN CHOOSE FROM 8 MODELS TO MEET YOUR WORKING REQUIREMENTS



expand DH steam turbine line

The latest in a long series of advancements in the Dean Hill line of horizontal steam turbines is the addition of three new turbines introduced as intermediate models. These new models effect a more gradual increase in power ratings in the horizontal line. The reduced "spread" between ratings in the new 8-model line gives you a better opportunity to match the turbine to the job within a very close margin. Of course, this is always to your advantage in turbine selection.

Because the new models incorporate all the newest improvements made on the other sizes, the Dean Hill horizontal line is one of the most *advanced, complete* lines in the world. With single-stage construction and sleeve bearings, they are specifically designed to operate at medium steam pressures. Low power consumption results in outstanding operational economy of every model in the line.

Write for Catalog No. 500 for details on both vertical and horizontal DH turbines. Information includes cut-a-way illustrations, detailed line drawings, tables, horsepower curves.

DEAN DH HILL PUMP COMPANY

Pump and Turbine Engineers Since 1893
Indianapolis 7, Indiana

Sales Offices In:
Chicago, New York, San Francisco, Boston, Cincinnati, Denver, Albuquerque, El Paso, Salt Lake City, New Orleans, Philadelphia, Tulsa, Los Angeles, Pittsburgh, Houston, Dallas, St. Paul, Toledo, Cleveland, Grand Rapids, Birmingham, Ala., Memphis, Richmond, Mexico City, Montreal, Reading, Pa. The Hague, Washington, Charlotte, Casper, Wyo., Knoxville.

For more data on advertised products, use Readers' Service Cards, last page.

Harbison-Walker castable refractories do many refinery jobs *most satisfactorily*

The many refractory requirements for the diversified refinery units are fulfilled most advantageously by Harbison-Walker Castables especially adapted for each particular purpose.

The excellent service resulting from the use of the various classes of Harbison-Walker Castable Refractories is due to their desirable properties, such as volume stability and strength over a wide temperature range, low permeabilities and thermal conductivities, and their high resistance to abrasion and chemical attack.

The brief descriptions of the brands of Harbison-Walker Refractory Castables principally used for refinery service, at the right, serve to illustrate their outstanding properties.

HARBISON-WALKER CASTABLES

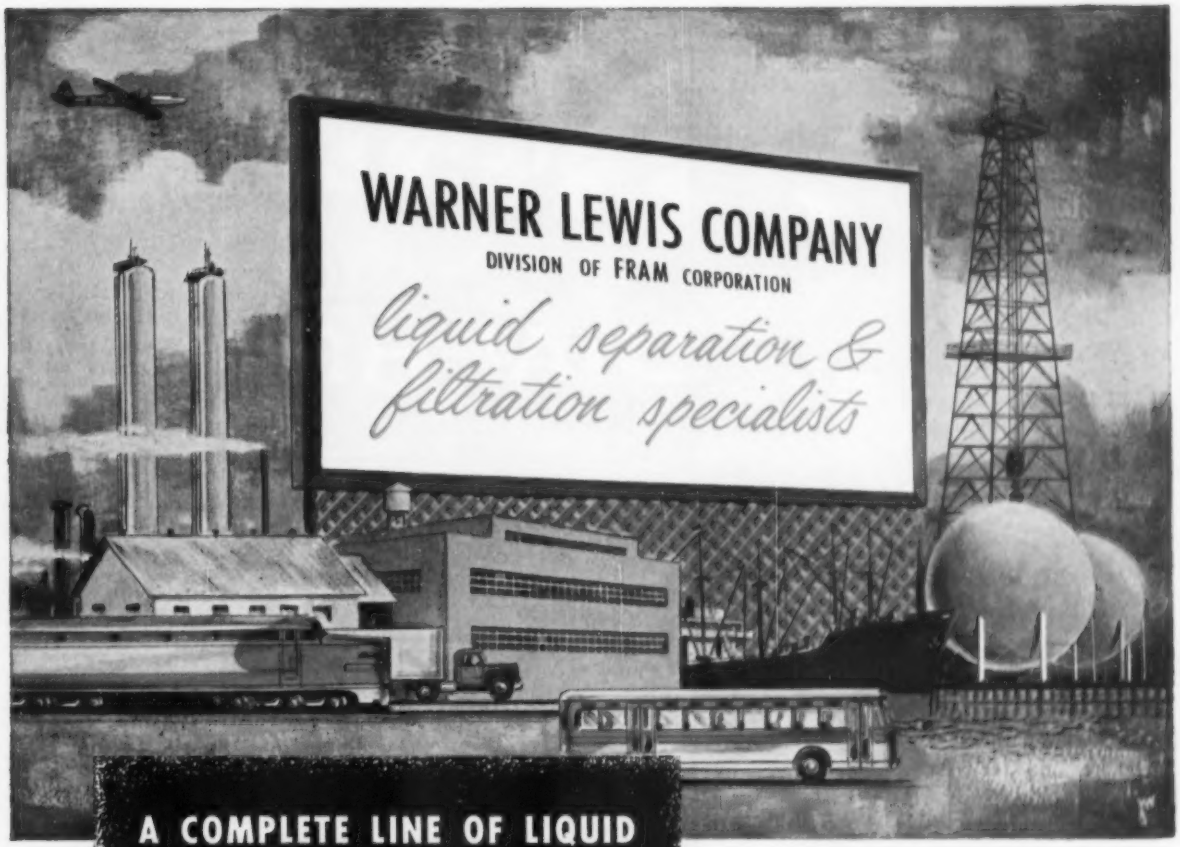
H-W EXTRA STRENGTH CASTABLE—Strongest of the refractory castables—it has exceptional strength and resistance to erosion over the range of temperatures up to its service limit of 2400° F.

H-W 56 LIGHTWEIGHT CASTABLE—Possesses good mechanical strength, light weight and unusually high insulating value.

H-W HIGH-ALUMINA CASTABLE—A highly refractory castable having a service limit of 3000° F. Suitable for use at extremely high temperatures.

H-W CHROME CASTABLE—A superior chrome ore base monolithic refractory which, because of its composition, is most resistant to various fluxes at high temperatures.

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES *General Offices:* Pittsburgh 22, Pennsylvania
WORLD'S LARGEST PRODUCER OF REFRACTORIES



A COMPLETE LINE OF LIQUID SEPARATORS AND FINE FILTERS FOR LIGHT PETROLEUM PRODUCTS

EXCEL-SO D-Model Filter

HP-700 High Volume Separator Filters

FRAM Liquid Separator Filters

FRAM Industrial Filters

DIVISION OF FRAM CORPORATION

The extensive research facilities and wide experience of FRAM and WARNER LEWIS COMPANY are now combined to provide scientific liquid separation and filtration for Refinery process streams, pipelines, and petroleum marketing installations.

Inquiries are invited on your particular problems.

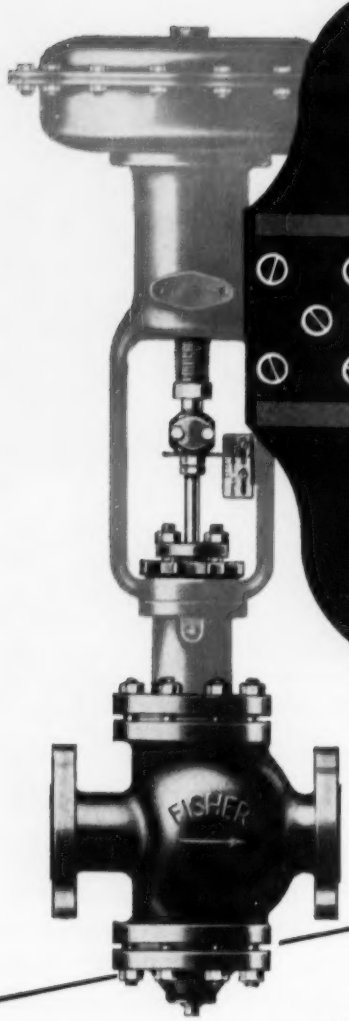
WARNER LEWIS COMPANY

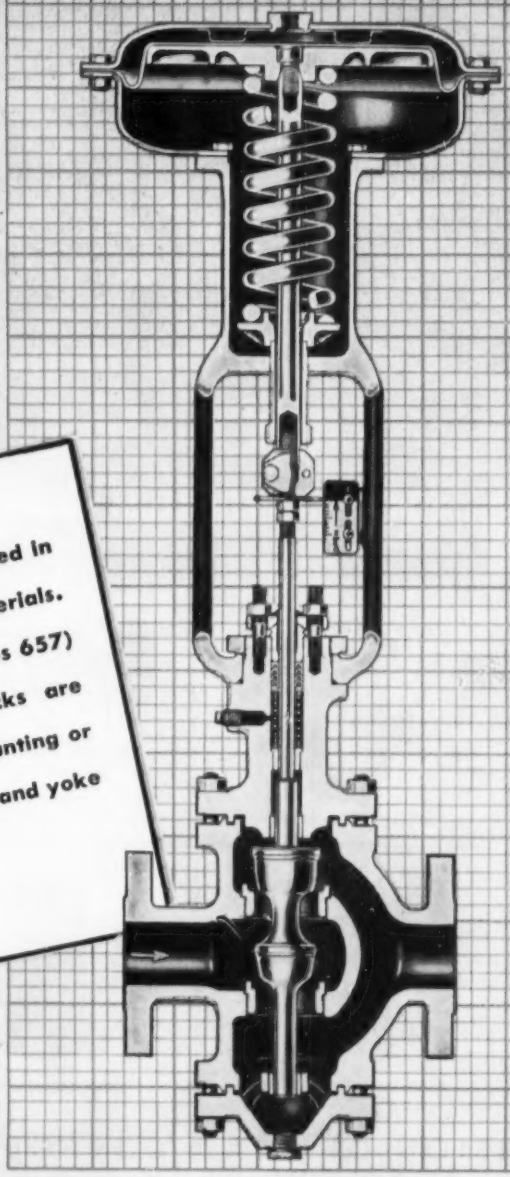
BOX 3096 • TULSA, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.

FISHER®

DIAPHRAGM





● Fisher Diaphragm Motor Valves are furnished in a wide variety of pressure ratings and materials. Topworks may be either direct acting (Series 657) or reverse acting (Series 667). Handjacks are available for either diaphragm casing mounting or yoke mounting. There are six diaphragm and yoke size combinations.

Improved

MOTOR VALVES

Improved PERFORMANCE FEATURES

- Bolted-clamp type stem connection allows stem adjustment of 50% of total travel. Can be disconnected in the field without stem damage. Will not shake loose from vibration or rotational inner valve forces.

- Rugged body to yoke connection with hammer lug nut. Topwork can be removed without disturbing stuffing box.

- Specially designed Buna N molded diaphragms with Nylon insert retain superior flexibility at low ambient operating temperatures. Provides linearity between operating pressure signal and travel, and gives maximum effective area.

- Bolted gland stuffing box with Teflon packing.

- Stainless steel clear view travel indicator.

- Spring ranges: 3 to 15 psi; 6 to 30 psi.

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER

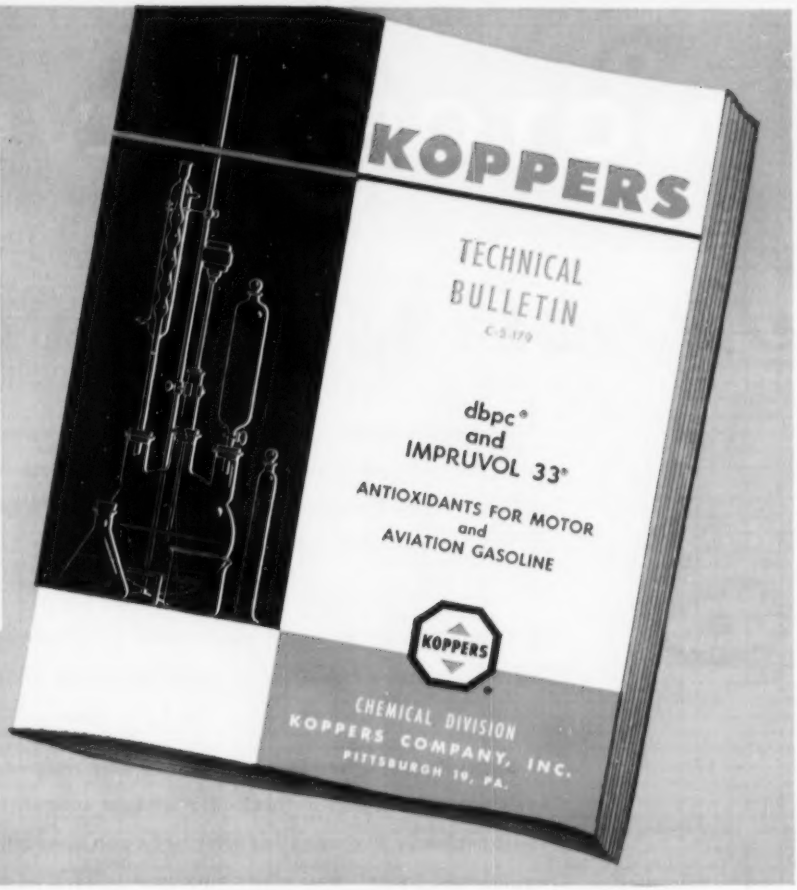
Since 1880

For more data on advertised products, use Readers' Service Cards, last page.

Want to improve gasoline quality and reduce treating costs?

Send for this

NEW BULLETIN NOW!



NATIONAL ENGINEERS' WEEK

This new technical bulletin on **dbpc*** antioxidant (2,6 di-tertiary-butyl-para-cresol) was developed to help the refiner understand more fully the many factors which influence gasoline gum formation and automotive induction system deposits. Much of the data is dramatically revealed through newly designed laboratory equipment which is described in detail. And a new inhibiting practice is outlined for the refiner who wishes to improve gasoline quality while reducing treating costs.

Interesting charts, tables, and effectiveness graphs on **dbpc** antioxidant, in use and in storage, are contained in the bulletin. Furthermore, actual comparisons are made with different types of inhibitors to prove the efficiency and economy of **dbpc** antioxidant.

• • •

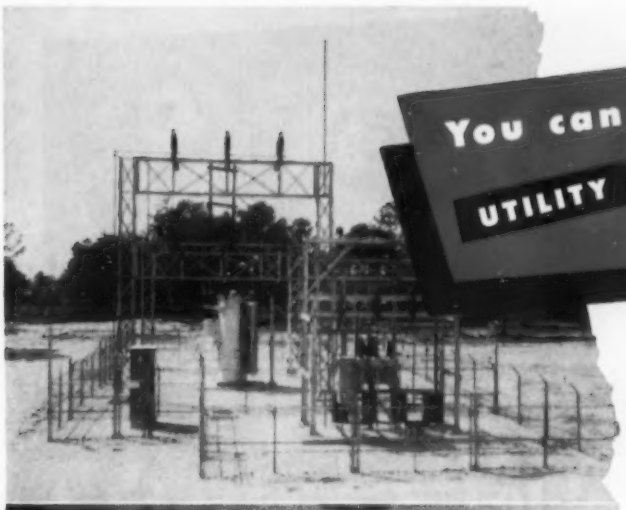
Send for your free copy of this factual, informative bulletin, today. Find out how you can make a better gasoline at less cost. Write to:

KOPPERS COMPANY, INC.
Chemical Division, Dept. PR-26, Pittsburgh 19, Pennsylvania

KOPPERS

KOPPERS CHEMICALS

SALES OFFICES: NEW YORK · BOSTON · PHILADELPHIA · ATLANTA · CHICAGO · DETROIT · HOUSTON · LOS ANGELES
In Canada: Dominion Anilines and Chemicals, Ltd., Toronto, Ontario



You can do it CHEAPER with UTILITY Electric Power

Modern. Low-Cost. Automatic. Labor Saving. Pushbutton Control . . . That's what this pipeline service company gets from Utility Electric Power. The rock bottom economy of using Utility Electric Power . . . plus the advantages of clean, dependable, and trouble-free efficiency . . . makes Utility Electric Power your BEST BUY for meeting any power requirement.

CALL YOUR LOCAL ELECTRIC UTILITY COMPANY FOR POWER FACTS

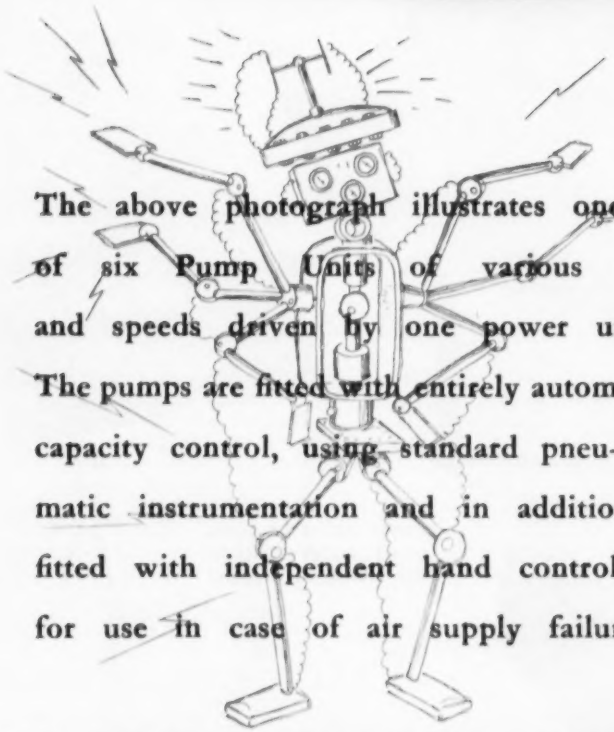
ORGANIZED IN THE INTEREST OF GREATER SERVICE TO THE PETROLEUM INDUSTRY

Petroleum Electric Power Association

P. O. BOX 2771, DALLAS, TEXAS

For more data on advertised products, use Readers' Service Cards, last page.

Automation comes to the Refinery

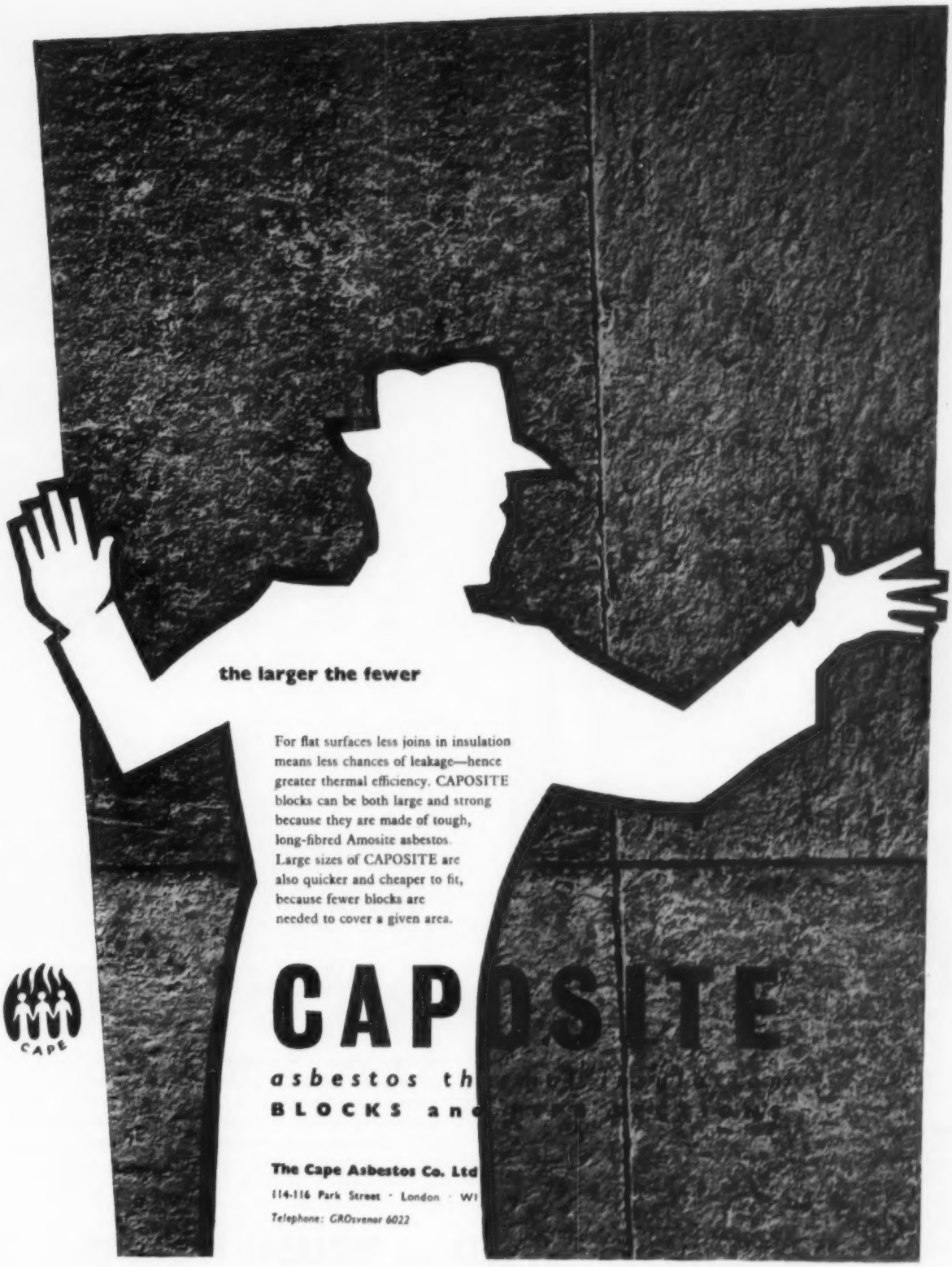


The above photograph illustrates one of four assemblies of six Pump Units of various capacities and speeds driven by one power unit. The pumps are fitted with entirely automatic capacity control, using standard pneumatic instrumentation and in addition are fitted with independent hand control for use in case of air supply failure.

E.C.D LTD
TONBRIDGE · KENT

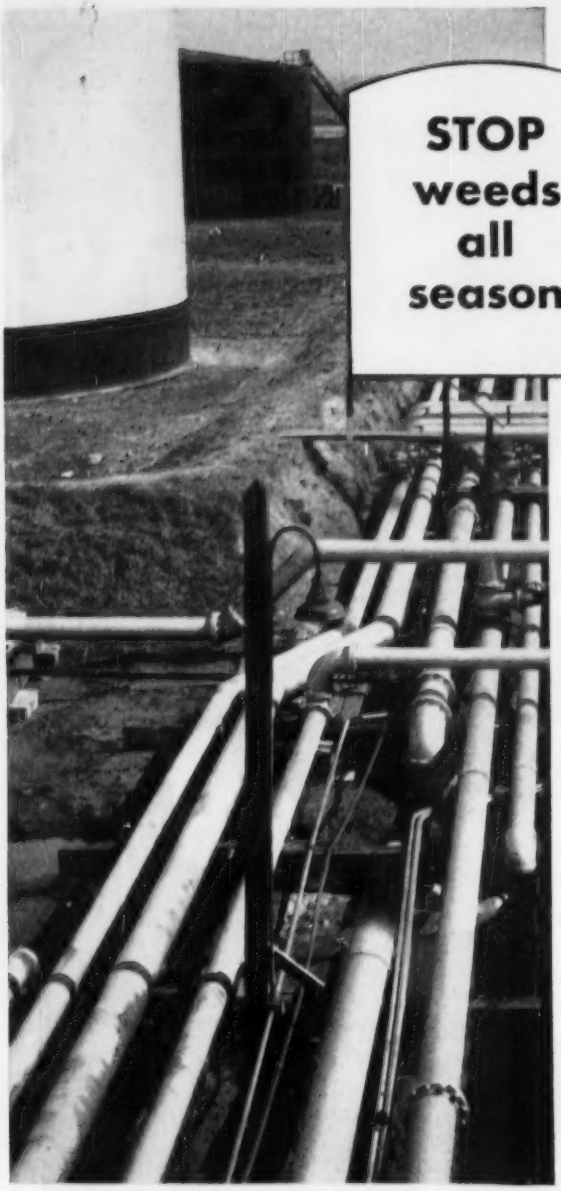
E.C.D. LIMITED · ENGINEERS · TONBRIDGE · KENT · ENGLAND

Telephone TONbridge 2237 (3lines) Telegrams TONMIL, TONBRIDGE


the larger the fewer
For flat surfaces less joins in insulation means less chances of leakage—hence greater thermal efficiency. CAPOSITE blocks can be both large and strong because they are made of tough, long-fibred Amosite asbestos. Large sizes of CAPOSITE are also quicker and cheaper to fit, because fewer blocks are needed to cover a given area.
CAP OSITE
asbestos th
BLOCKS an
The Cape Asbestos Co. Ltd
114-116 Park Street · London · W1
Telephone: GROsvenor 6022
CAPE

Cape Asbestos (Canada) Ltd., 200 Bloor Street, East, Toronto, Ontario
United States Enquiries: **North American Asbestos Corp., Board of Trade Bldg., Chicago 4, Ill.**

For more data on advertised products, use Readers' Service Cards, last page.



Still weed-free one year after treatment with "Telvar." The area around the tanks and pipeline was sprayed with a single treatment of "Telvar" a year before this photo was taken. Weed-control costs are cut with "Telvar" because it gives thorough, long-term weed control.

FREE ILLUSTRATED BOOKLETS describe how to control weeds and brush with Du Pont chemicals. Write to Du Pont, Grasselli Chemicals Dept., Rm. D-4032, Wilmington, Del. In Canada, Du Pont Company of Canada Limited, 80 Richmond Street West, Toronto, Canada.

Spray just once with Du Pont TELVAR®

WEED KILLERS

When you use "Telvar" weed killers, vegetation is killed through the roots and regrowth is prevented because the chemical remains in the soil . . . provides residual action all season long. And low dosages (1 to 1½ lbs. per 1,000 sq. ft.) make it cost little for the results you obtain. Such low rates also mean less handling, less use of storage facilities.

"Telvar" weed killers come as wettable powders, are non-corrosive, non-flammable, non-volatile, low in toxicity to humans and livestock.

Include "Telvar" weed killers in your weed-control program this year. Prove to yourself how these products of Du Pont research can help cut your maintenance cost to new low levels.

• • •

Where brush is a problem, Du Pont Ammate® X weed and brush killer is the product you need. It kills more kinds of brush with unusual safety. With ordinary precautions, "Ammate" X may be used close to such crops as cotton, tomatoes, soybeans and peanuts.

On all chemicals, follow label instructions and warnings carefully.

DU PONT
REG. U.S. PAT. OFF.

WEED and BRUSH KILLERS

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Reduce Down-Time Costs

with ROCKWELL-Nordstrom VALVES

The two most common valve problems that cause excessive down-time costs are seat failure (leakage) and wear. Performance records in thousands of refineries and gasoline plants prove that Rockwell-Nordstrom valves cut down-time costs because they *stay leakproof* and *wear longer in service* than any other valve. In Rockwell-Nordstrom valves, there are no exposed seats to be cut-out or corroded. Leakproof, positive shut-off is assured by pressurized lubricant sealing. Lubricant also eliminates the metal-to-metal friction that causes ordinary valves to wear out so quickly.

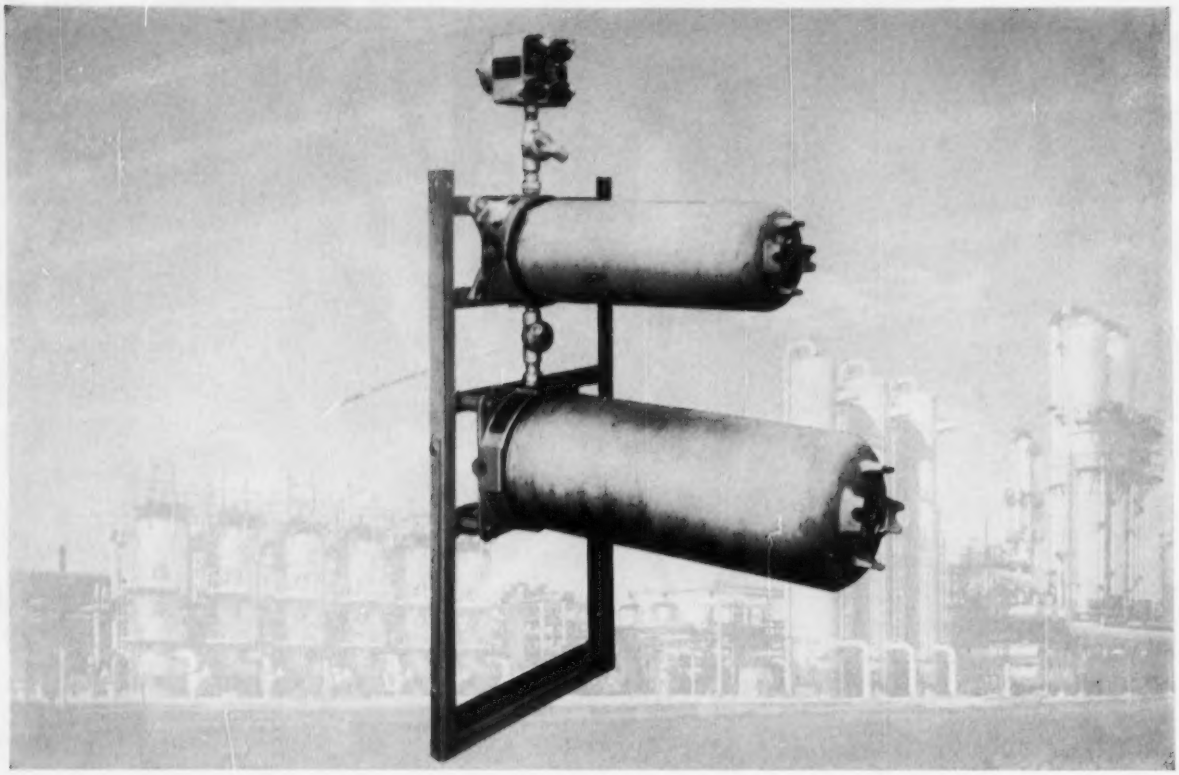
The low maintenance cost and dependability of Rockwell-Nordstrom valves is a matter of record, yet they cost no more to buy, often less, than ordinary valves. Available in a complete range of sizes and pressure ratings. Write today for more information: Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Canadian Valve Licensee: Peacock Brothers Ltd.

ROCKWELL-Nordstrom **VALVES**

Lubricant Sealed for Positive Shut-Off

40th YEAR *of lubricated plug valve leadership*



The BICHROMATOR® Infrared Analyzer

Designed for Continuous Gas and Liquid Analysis Under Plant Conditions

Here is the first industrial infrared analyzer based on the proven principles of laboratory spectrometers and used for continuous monitoring and control of chemical processes. The Bichromator Analyzer is a two wave length, dispersion-type instrument, applying base-line density principles of the infrared laboratory to continuous process analysis.

It is an extremely stable and rugged instrument with no moving optical parts. The simple radiation null principle and closed loop servo system insure rapid response, virtual freedom from source or line current variation, or change in amplifier linearity. This photometric system allows full-scale recorder operation with as little as 3% change in transmission.

The Bichromator Analyzer continuously measures the concentration of one component in an industrial sample. It is set on two wave length intervals; one, unique to the sample being analyzed (the component of interest), the other at a reference wave length where the sample does not absorb radiation. The ratio of the energy at the two wave lengths is proportional to the concentration of the component of interest, and is indicated on the recorder directly as concentration.

Perkin-Elmer

CORPORATION

Norwalk, Connecticut

Thousands of laboratory infrared spectrometers now in use attest to the accuracy and stability inherent in the design of the dispersion instrument. Furthermore, the performance of the Bichromator Analyzer *can be predicted* from laboratory spectrometer data and tied to present laboratory control procedures.

Check these features

1 Sample cell in separately purgeable compartment outside main instrument for ease of checking without exposing instrument proper to plant atmosphere.

2 Built-in test circuit for rapid, simple instrument checks *in hazardous* areas without need for tools or test equipment.

3 Electronics system features unitized construction with functional sub-assemblies for simplified servicing.

4 Special by-pass sampling cells designed to give fast response and eliminate sampling lag.

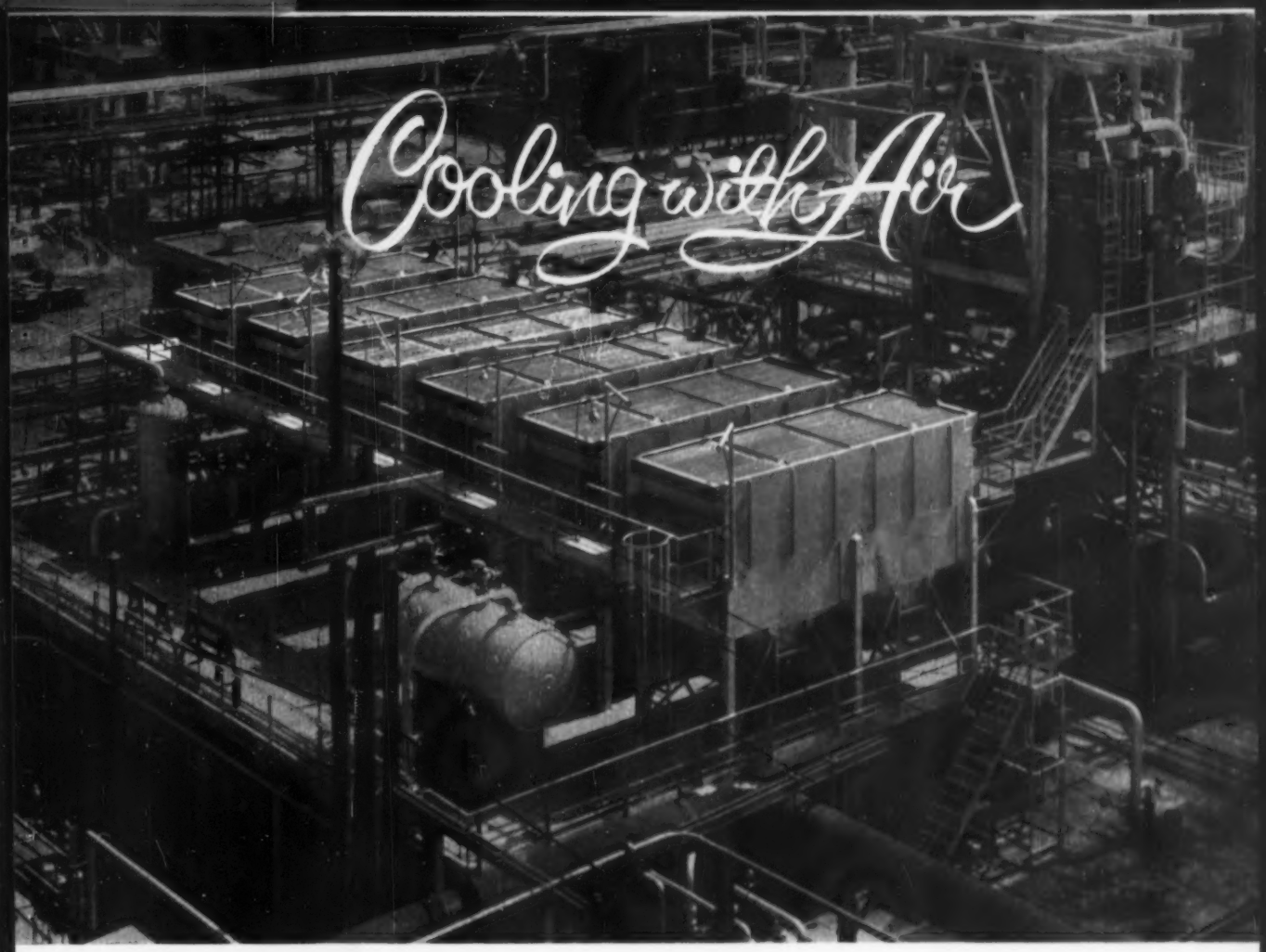
5 Handles unstable or corrosive gases and liquids.

6 Handles hot or cold samples.

7 Interchangeable dispersion units, factory pre-set, for each specific control problem.

8 Field conversion to a new problem is possible.

For more data on advertised products, use Readers' Service Cards, last page.



Solo-aire units condense and cool three streams from a refinery process unit

SERVICE NUMBER ONE

Mixed steam and hydrocarbon vapor condenser and cooler.

Gravity	47°API
Inlet Temperature	340°F
Outlet Temperature	140°F
Heat Removed	19,500,000 BTU/hr.

SERVICE NUMBER TWO

Mixed steam and hydrocarbon vapor condenser and cooler.

Gravity	31°API
Inlet Temperature	463°F
Outlet Temperature	135°F
Heat Removed	34,100,000 BTU/hr.

SERVICE NUMBER THREE

Hydrocarbon liquid cooler.

Gravity	43°API
Inlet Temperature	430°F
Outlet Temperature	130°F
Heat Removed	10,000,000 BTU/hr.

If water rather than air were used as a cooling medium for these services, about 4500 gallons per minute would have been required.

These Hudson Solo-aires are operating with complete satisfaction in one of the world's major oil refineries. They were designed and built to rigid specifications for oil refinery service including API-ASME Code for pressure parts, explosion proof motor drives, and corrosion resistant structural steel parts, and were specially designed to fit into a congested area.

In addition to Solo-aires Hudson manufactures the COMBIN-AIRE unit, which uses a combination of air and water for cooling, and also cooling towers for conventional cooling of water.

HUDSON

ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

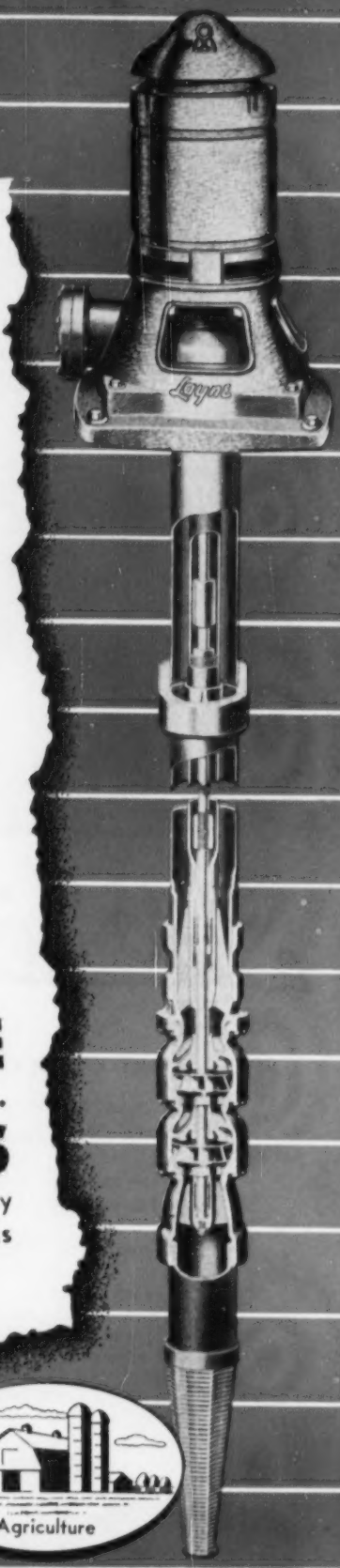
This Giant Among Utilities ...Relies on Layne!

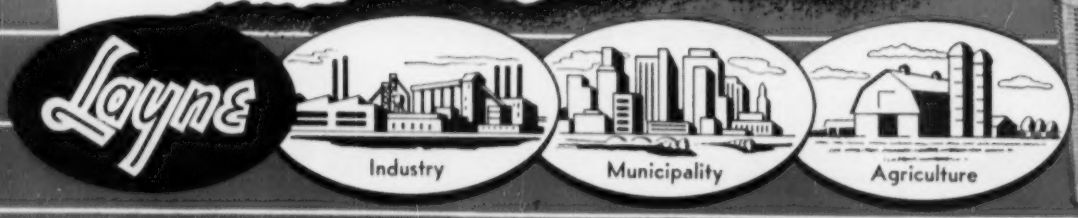
IN PRODUCING 9.4 billion kilowatt hours of electric energy yearly, the generating plants of Philadelphia Electric Company, industrial giant of the Delaware Valley, need 3.25 billion gallons of water—daily. Borrowed from the Delaware and Schuylkill Rivers, this astronomical quantity of water is vital to operation.

Philadelphia Electric, in common with so many other utilities, large and small, relies on Layne for many jobs essential to production, maintenance and safety.

To know all about Layne pumps and their leadership in industry, "ask the man from Layne."

LAYNE
& BOWLER, INC.
MEMPHIS
General Offices and Factory
LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD





Water Wells • Vertical Turbine Pumps • Water Treatment

PERFORMANCE VERIFIED / by acid test

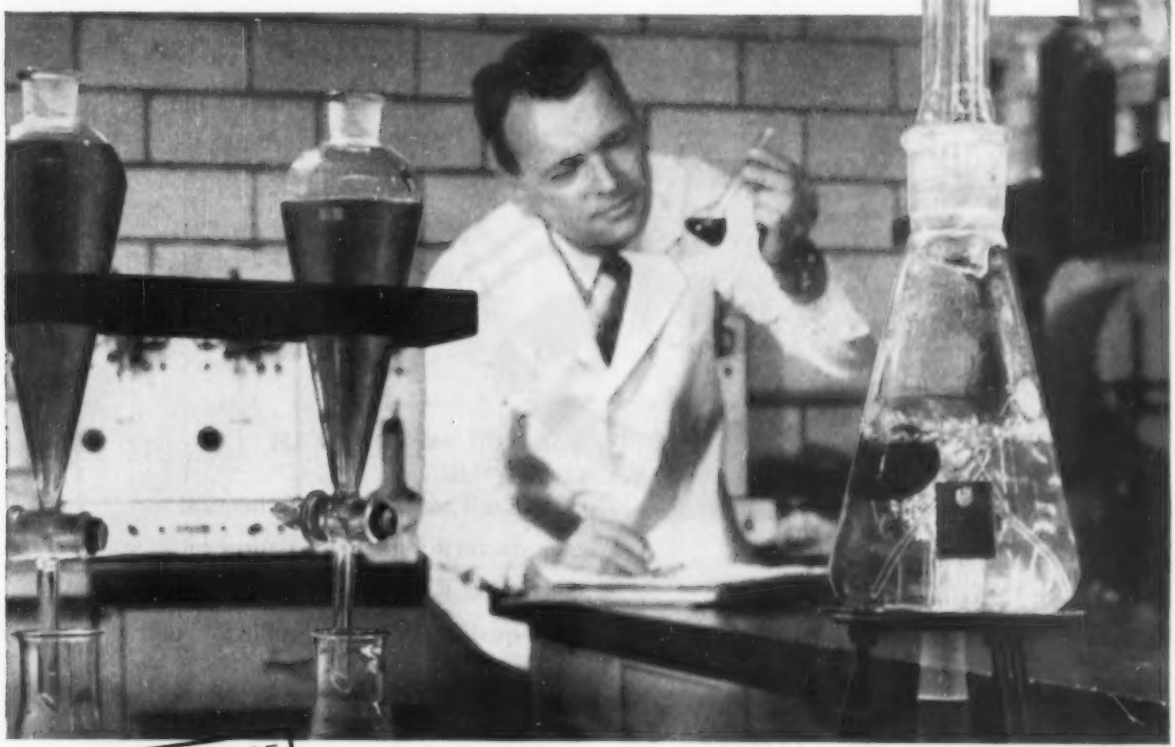
Even before a Powell Corrosion Resistant Valve is made, it must pass the acid test. For quality control begins with the very materials which go into Powell Valves.

Constant laboratory control is one of the many ways we make certain that Powell Corrosion Resistant Valves will give dependable flow control. Another is the final step of manufacture: *every Powell Valve is subjected to an actual line test.*

To keep pace with the rapidly expanding chemical and process industries, Powell has designed many new types of Corrosion Resistant Valves. The variety of pure metals and special alloys in which they are available has grown to such an extent that today there is a Powell Corrosion Resistant Valve to control the flow of almost every known, corrosive fluid.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our COMPLETE *quality line* which has PERFORMANCE VERIFIED.

The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR



PERFORMANCE PV VERIFIED

FIG. 1503 SS (Sectional)—150-Pound Alloy Steel Gate Valve.

FIG. 3065 SS (Sectional)—300-Pound Bolted Cap Alloy Steel Horizontal Lift Check Valve.

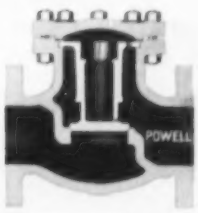


FIG. 1333 A (Sectional)—Integral Bonnet Angle Valve For Pressures of 1500 and 2500 W.S.P.

POWELL VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

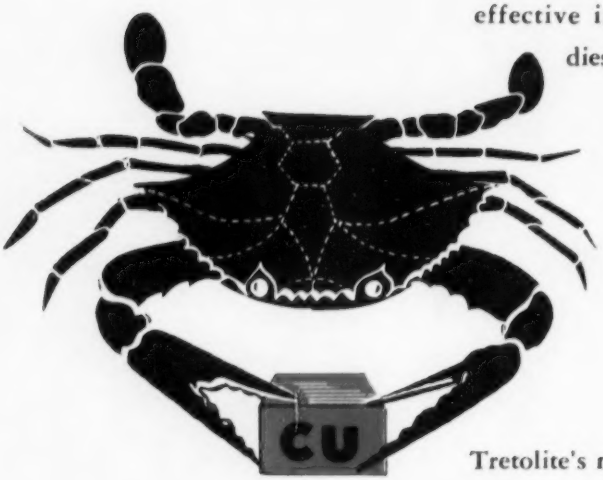
For more data on advertised products, use Readers' Service Cards, last page.

KUPLEX *

METAL DEACTIVATOR

FOR PETROLEUM PRODUCTS

Kuplex metal deactivator chelates copper and its compounds, preventing hydrocarbon deterioration caused by metal catalyzed oxidation. It is especially effective for the stabilization of gasolines, and is also effective in kerosines, jet fuels, diesel oils, burning oils and turbine oils.



Tretolite's many years of chemical manufacturing integrity assures refiners that Kuplex will be another high-quality Tretolite product.

* *A new Tretolite Company Product*

For samples and technical data, ask your Tretolite refinery engineer, or write to

TRETOLITE COMPANY

A Division of Petrolite Corporation
369 Marshall Avenue, St. Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

Chemicals and Services for the Petroleum Industry

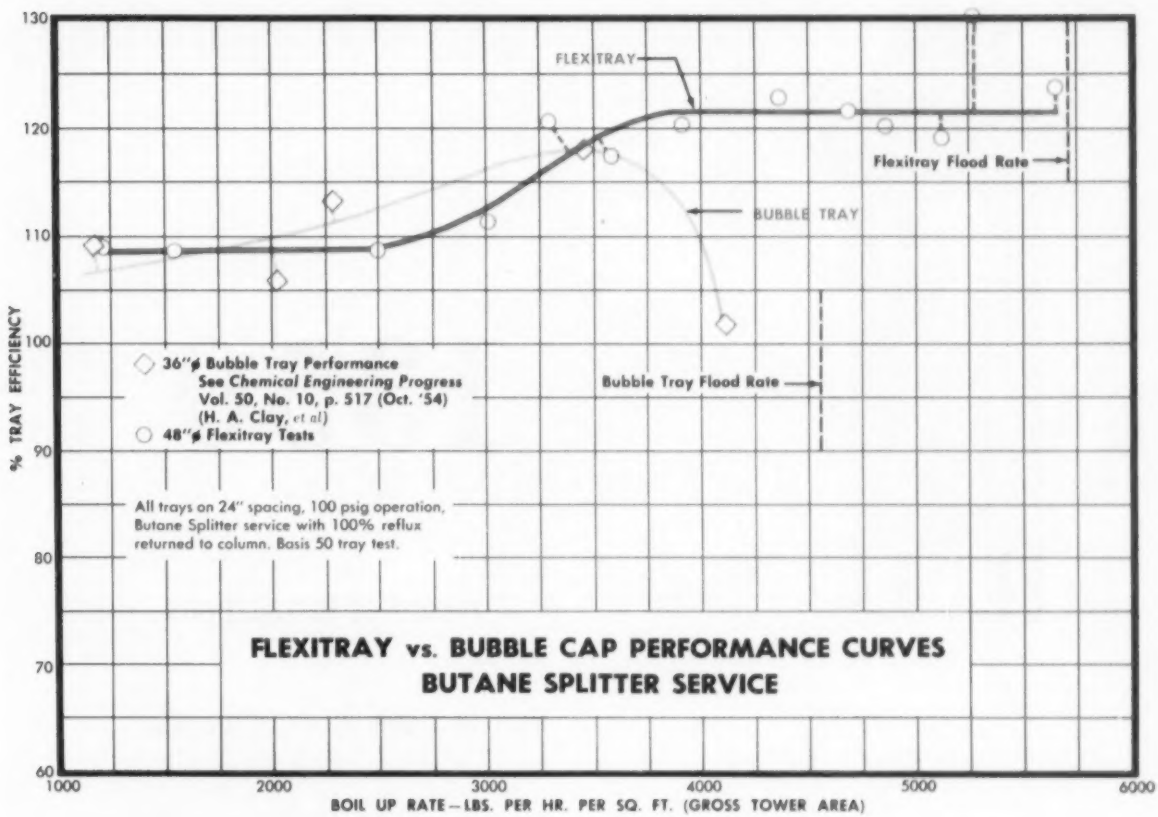
DESALTING • DEMULSIFYING • CORROSION PREVENTIVES • SCALE INHIBITING • ASPHALT ADDITIVES • FUEL OIL ADDITIVES • WATER DE-OILING • PARAFFIN REMOVAL • PRODUCTION STIMULATION BACTERICIDES • METAL CONDITIONERS

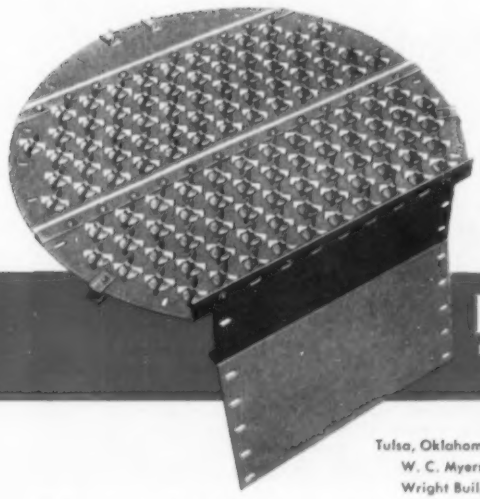
KU 2

WHY

Top Performers Prefer Koch Flexitrays

FOR BUTANE SEPARATION





Close separations in the butane range are common problems in Refineries and Natural Gasoline Plants, as well as many Petrochemical Plants.

The above graph illustrates the results of an exhaustive series of very carefully run tests by one of the major oil companies to confirm the actual advantages of the Flexitray over the bubble tray. Note the added capacity and sustained efficiency of the Flexitray at rates beyond the flood rate of bubble trays. The performance records of the Koch Flexitray are outstanding. Wire, write, or phone us on its application to your problem.

KOCH ENGINEERING COMPANY, INC.

DESIGNERS AND FABRICATORS OF MODERN TRAYS

321 WEST DOUGLAS — WICHITA 2, KANSAS

REPRESENTATIVES

Tulsa, Oklahoma, Repr.
W. C. Myers Co.
Wright Building

Houston, Texas, Repr.
Alpha Engineering Co.
P. O. Box 12371

Eastern Repr.
Crawford Engineering Co.
295 Madison
New York, New York

Pittsburgh, Pa., Repr.
D. D. Foster Company
501 Alcoa Building

West Coast Repr.
Jacobs Engineering Co.
3018 E. Foothill Blvd.
Pasadena, California

1350

Since 1940

A record of installations

that in itself is incomparable

just as all Petro Chem Isoflow Furnaces

are most efficient by any comparison

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

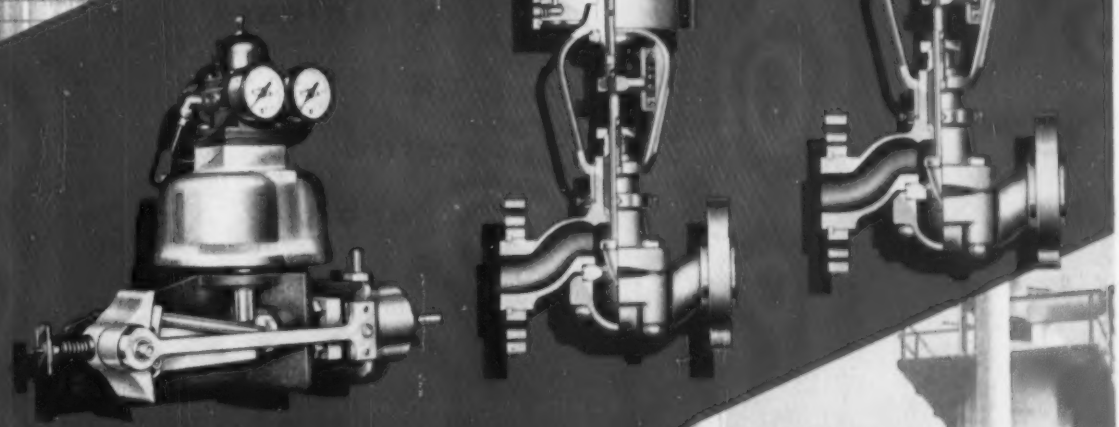
REPRESENTATIVES:

Rawson & Co., *Houston* • Wm. H. Mason Co., *Tulsa* • Lester Oberholtz, *Los Angeles* • Faville-Levally, *Chicago* • D. D. Foster, *Pittsburgh* • Turbex, *Philadelphia* • Flagg, Brackett & Durgin, *Boston* • G. M. Wallace, *Denver*

International Licensees and Representatives: SETEA — S.A. Comercial, Industrial, y de Estudios Tecnicos, Buenos Aires, Argentine • Industrial Proveedora, Caracas, Venezuela • Firma Dr. C. Otto & Comp. G.M.B.H., Bochum, Germany • Birwelco Ltd., Birmingham, England • Societe Anonyme Heurtey, Paris, France • Societe Anonyme Belge, Liege, Belgium • Huertey Italiana S.P.A., Milan, Italy

For more data on advertised products, use Readers' Service Cards, last page.

Reward your process
WITH THE BEST IN CONTROL VALVES



FOR BETTER CONTROL

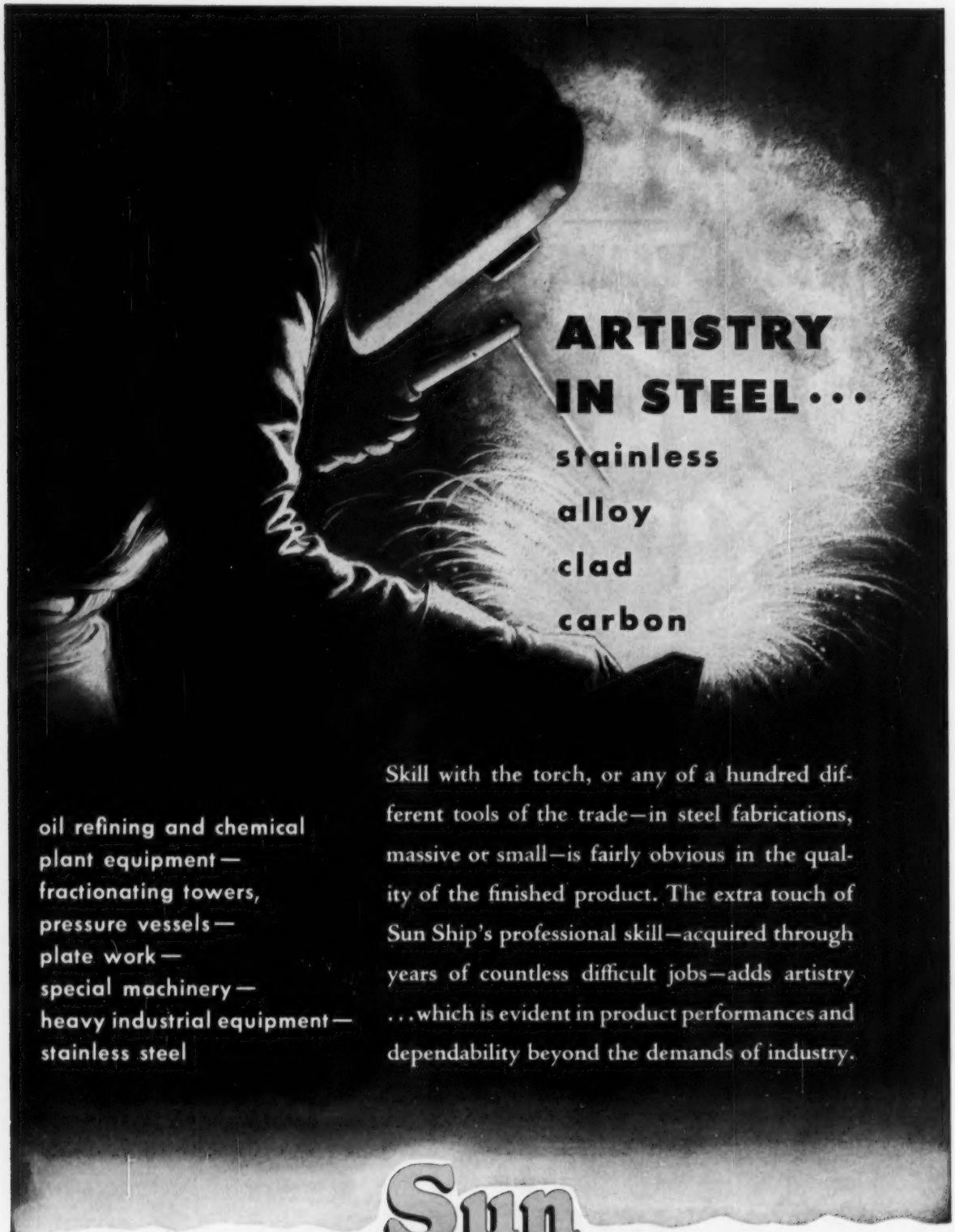
You reward your process with the best in control valves when you call for Annin Domotor Control Valves, specified by engineers responsible for the most advanced processes throughout the world. Domotor control valves are no longer new, but they are still the most advanced fluid control valves available anywhere. Whether your primary problem is control accuracy, tight closure, hi-resistance to erosion and corrosion, wide rangeability or low maintenance, you, too, should insist on Domotor Control Valves, produced by The Annin Company, oldest manufacturer of valves DESIGNED for modern automatic control.

Write now for your copy of Annin's new catalog on valves for fluid control.

ANNIN Control VALVES

THE ANNIN COMPANY
4570 EAST TELEGRAPH ROAD, LOS ANGELES 22, CALIFORNIA

For more data on advertised products, use Readers' Service Cards, last page.



oil refining and chemical
plant equipment—
fractionating towers,
pressure vessels—
plate work—
special machinery—
heavy industrial equipment—
stainless steel

Skill with the torch, or any of a hundred different tools of the trade—in steel fabrications, massive or small—is fairly obvious in the quality of the finished product. The extra touch of Sun Ship's professional skill—acquired through years of countless difficult jobs—adds artistry ...which is evident in product performances and dependability beyond the demands of industry.

Sun
SHIPBUILDING & DRY DOCK COMPANY
SINCE 1916
ON THE DELAWARE • CHESTER, PA.
25 BROADWAY · NEW YORK CITY

L&M PIPELINE MARKER-VENTS

LASTS THE LIFE OF THE LINE . . .
LESS EXPENSIVE THAN A FIELD-WELDED VENT

HEAVY ALUMINUM
Entire marker-vent is cast of heavy aluminum alloy. Resists damage from rifle bullets.

CHOICE OF COLORS
Signs available in any color combination to match company colors.

LARGE PANEL
7" by 12" panel offers sufficient space for company trade mark and message in raised letters.

SCREENED VENTS
Heavy rust-proof screening keeps out insects, allows proper venting.

HEAVY COLLAR
Fits 2", 3" or 4" pipe. Weldable collar available at slightly higher cost.

EASY INSTALLATION
Simply slip the vent collar down over pipe and tighten two set screws.

Topaz sales engineers will make field surveys and free estimates of your particular needs.

● L & M Pipeline Marker-Vents are ruggedly designed and constructed to withstand the ravages of weather and vandalism. Venting and marking your pipeline in one operation means considerable savings to you in labor and materials. L & M also manufactures aerial markers, plaques and safety signs built to your specifications. Reflective signs for nighttime reading available in all models.

SOLELY DISTRIBUTED BY

ToPaz

TOD PAZDRAL
PIPELINE SPECIALTIES
2525 South Boulevard • Houston, Texas
Phone JAckson 2-1403

2" MARKER VENT

SAFETY SIGNS

AERIAL MARKERS

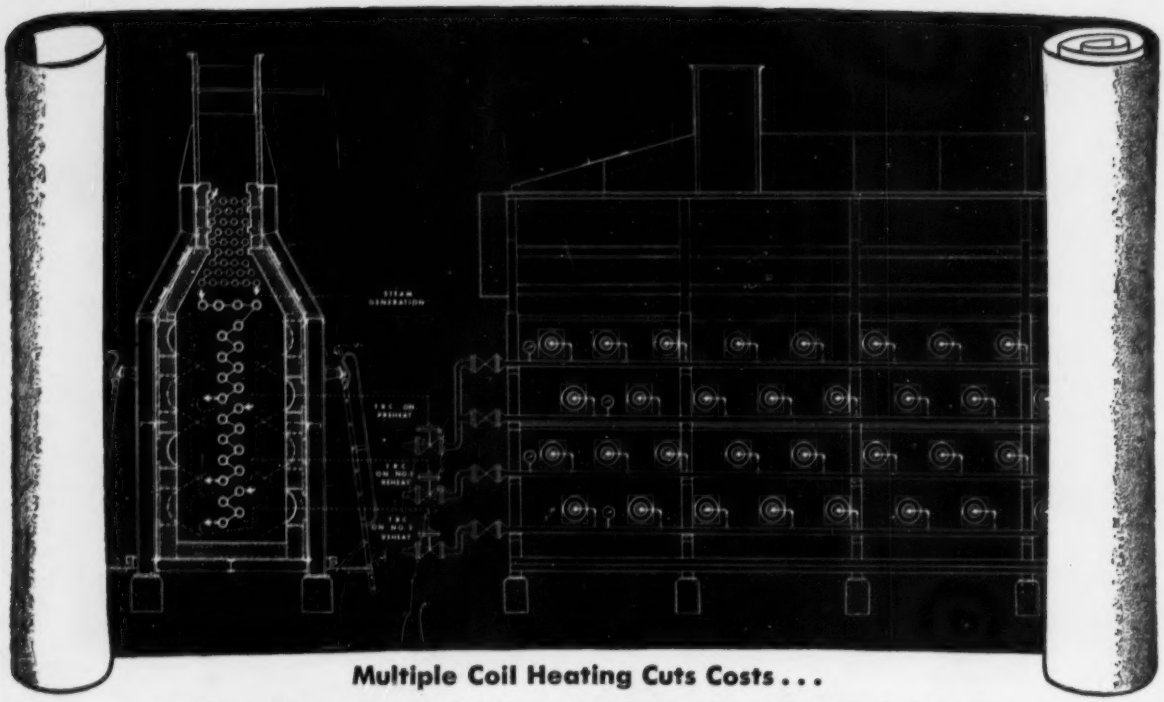
Dealerships available in many domestic and foreign territories.
Write or wire Tod Pazdral Pipeline Specialties for details.

Patent Pending

For more data on advertised products, use Readers' Service Cards, last page.

ONE HEATER DOES THE JOB OF THREE

with SELAS *Zone Control*



Multiple Coil Heating Cuts Costs . . .
Is More Efficient . . . Requires Less Space for Catalytic Reforming

● Zone Control of Selas Gradiation Heaters permits independent operation of more than one coil in a single radiant setting. By proportional variation of absorption rates in accordance with maximum allowable tube wall, film or process temperature—whichever is limiting—each section of the heating surface is more effectively utilized . . . thereby minimizing residence time and pressure drop.

Selas Gradiation Heaters are currently in operation in most of the major catalytic reforming processes and provide:

- Compact heating units with multiple coils and absolute temperature control in a single radiant chamber.
- Flexibility in shaping the heating curve.
- Complete combustion with little or no excess air.
- Prolonged tube life—lower maximum tube wall temperature, through more uniform circumferential heat distribution, minimizes corrosion rate.

Where two or more process streams require separate heating you'll find it worthwhile getting the facts on Selas Gradiation Zone Control.

Send for copy of reprint, "Try the Gradiation Heater for Economical Ethylene Production" and Bulletin 82, "Gradiation Heating for Petroleum and Chemical Processing."

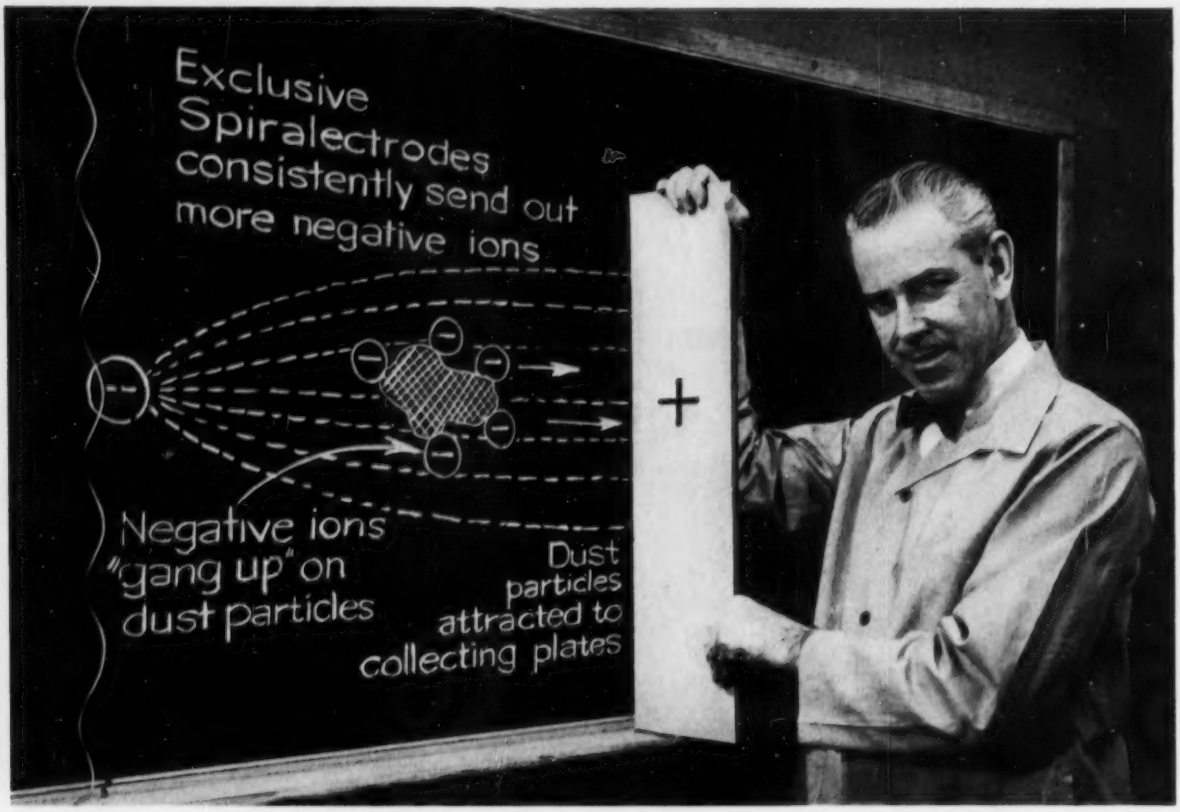
SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

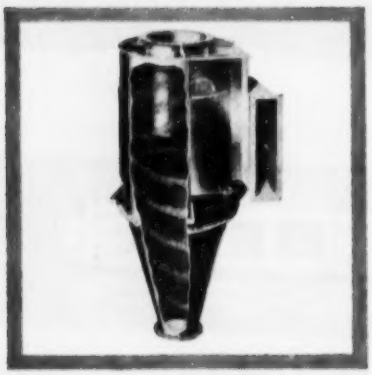
Heat and Fluid Processing Engineers
DEVELOPMENT • DESIGN • CONSTRUCTION

In water conditioning... there's one way to be sure!

W. H. & L. D. BETZ, Philadelphia, Pa.

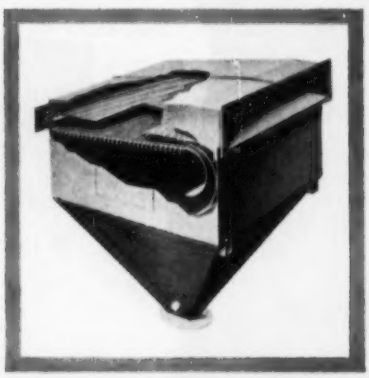
How a Buell Collection System "gangs-up" on dust to meet the toughest air pollution codes





Buell Cyclones also deliver extra collection efficiency to "gang-up" on dust: Exclusive Shave-off design harnesses double-eddy current and puts it to work.

With positive gas flow control for peak efficiency . . . plus continuous cycle rapping to eliminate puffing . . . Buell's "SF" Electric Precipitator really "gangs-up" on dust (even dust with high resistivity) to permit full production even under the most rigid anti-air-pollution codes.



Buell's Low Resistance Fly Ash Collector combines high efficiency to meet present day strictness, with low draft loss for natural or mechanical draft installations.

FOR THE COMPLETE STORY
Write:
Buell Engineering Company
Dept. 21-B, 70 Pine Street
New York 5, New York

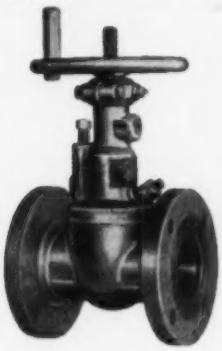
buell®

MECHANICAL ELECTRICAL

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

For more data on advertised products, use Readers' Service Cards, last page.

ORBIT VALVES HOLD



Full Round Opening Flanged End, Sizes: 1", 1½", 2", 2½", 3", 4".

Venturi Opening Only Flanged End, Sizes: 2", 2½", 3", 4", 6".

Screw End—full round opening. Sizes: 1", 1½", 2", 2½", 3", 4".

HYDROCARBONS

- NATURAL GAS
- ETHANE
- PROPANE
- BUTANE
- ETHYLENE
- PROPYLENE
- BUTADIENE
- BENZENE
- TOLUENE
- XYLENE

ORBIT VALVES ®

See 23rd Edition of Refinery Catalog for full particulars on Orbit Forged Steel ASA Class valves or write for Catalog 56-C.
A good range of sizes are available beginning with 1"

ORBIT VALVE COMPANY

P. O. BOX 699 *(For over 40 years)* TULSA 1, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.

IT'S EASY

TO SELECT A PRESSURE OR TEMPERATURE CONTROL FOR ANY APPLICATION WHEN IT'S A

MERCOID®

Write for this catalog

CONTENTS:

CONTROLS FOR PRESSURE—
DIFFERENTIAL PRESSURE—
TWO-STAGE PRESSURE—
TEMPERATURE—
TWO-STAGE TEMPERATURE
LIQUID LEVEL
FLOAT OPERATION
LEVER ARM OPERATION

CASE STYLES TO MEET VARIOUS REQUIREMENTS
INDOOR (General Purpose)
OUTDOOR (Weather Resistant)
HAZARDOUS LOCATIONS (Explosion-proof)

ALL MERCOID CONTROLS INCORPORATE SEALED MERCURY CONTACTS

Write for Catalog No. 856-G
THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

The Mail Box . . .

It's A Gold Mine

To The Editor:

The December issue of your PETROLEUM REFINER was really wonderful. This is a gold mine for me and for my students in my organic processes course here.

Lyle F. Albright, Professor
Department of Chemical Engineering,
Purdue University
Lafayette, Indiana

Questions Methods

To The Editor:

"Thermal Stresses in Piping Systems" by William E. Wilbur, which first appeared in PETROLEUM REFINER as a three-part series of articles, contained an approximate method of solution for multiple anchor problems.

Curiosity impelled me to analyze a configuration which Mr. Wilbur utilized, and the results are in extreme disagreement with his approximations. So much so, that it might be advisable to publish the results of analysis by a more refined method.

I have analyzed the system with both the Lochak & Kellogg methods, which Mr. Wilbur gave as reference, and would be pleased to forward the results if you are interested.

Mr. Wilbur's review and comments would be most welcome. However, it might be pertinent to add that the article is in no way intended to discredit Mr. Wilbur's approach to the problem, but rather to emphasize the possible saving money-wise by utilizing a more accurate method of analysis.

H. B. Ellis,
Reynolds, Smith and Hills,
Architects and Engineers
Jacksonville 1, Fla.

Editor's Note: Detailed calculations were included in Mr. Ellis' letter and have been reviewed by Mr. Wilbur.

Wilbur's Comment

I have been much interested in the communications with Mr. Ellis which you sent me, regarding the analysis of piping with three anchors.

I fear that I did not make it plain enough in my book that the method I proposed was merely a rough approximation, to be used if time did not permit a complete analysis. In our work of this nature we are always pressed for time, and a rough analysis such as I gave will frequently permit us to approve a line without further consideration. It was the intention of my book, not too well expressed, to recommend a more careful analysis of the doubtful lines.

I should be glad, however, to have you forward these comments of mine to Mr. Ellis, with my appreciation of his interest, and my thanks for the light he has thrown upon a difficult subject. For several years I have been hoping to find the time to pursue this phase further, and develop a better approximation, but so far I have not been able to do so.

William E. Wilbur
Whittier, Calif.

Errata

To The Editor:

I am very pleased with your condensation of the original article on petrochemicals in Canada prepared by R. G. Stevens and myself and appearing in your January issue.

Unfortunately there are a few inaccuracies in the article which I would like to bring to your attention. The Polymer Corporation production of synthetic rubber is shown in my paper as 90,000 tons in 1953, whereas you indicate the production as 90 million pounds annually. I believe it would be accurate to say that Polymer's present capacity is now in excess of 90,000 tons per year. You also state that the Polymer Corporation is operated by Dow Chemical of Canada, which is incorrect. Dow was one of three companies that joined in administering and operating Polymer's plant during the War years, but this arrangement has since been discontinued. Polymer Corporation, which is a Crown corporation, now operate and manage their own facilities.

Finally, you write that Sherritt Gordon Mines has announced the erection of an Alberta plant to manufacture ammonia and hydrogen from natural gas, whereas Sherritt Gordon have actually built such a plant and have been operating it for some time.

A. W. Hutchison,
Manager, Chemical Division
Shell Oil of Canada, Ltd.
Toronto, Ont.

For more data on advertised products, use Readers' Service Cards, last page.

JEFFERSON

GAS SCRUBBING AGENTS

monoethanolamine
diethanolamine } for sweetening natural and refinery gas

diethylene glycol
triethylene glycol } for dehydrating natural gas

These high-quality chemicals are produced at Jefferson's modern plant at Port Neches, Texas, and shipped from convenient distribution points at Port Neches, Houston, Chicago, Los Angeles and Tenafly, New Jersey. They are available for immediate delivery in tank cars, tank wagons or 55-gallon drums.

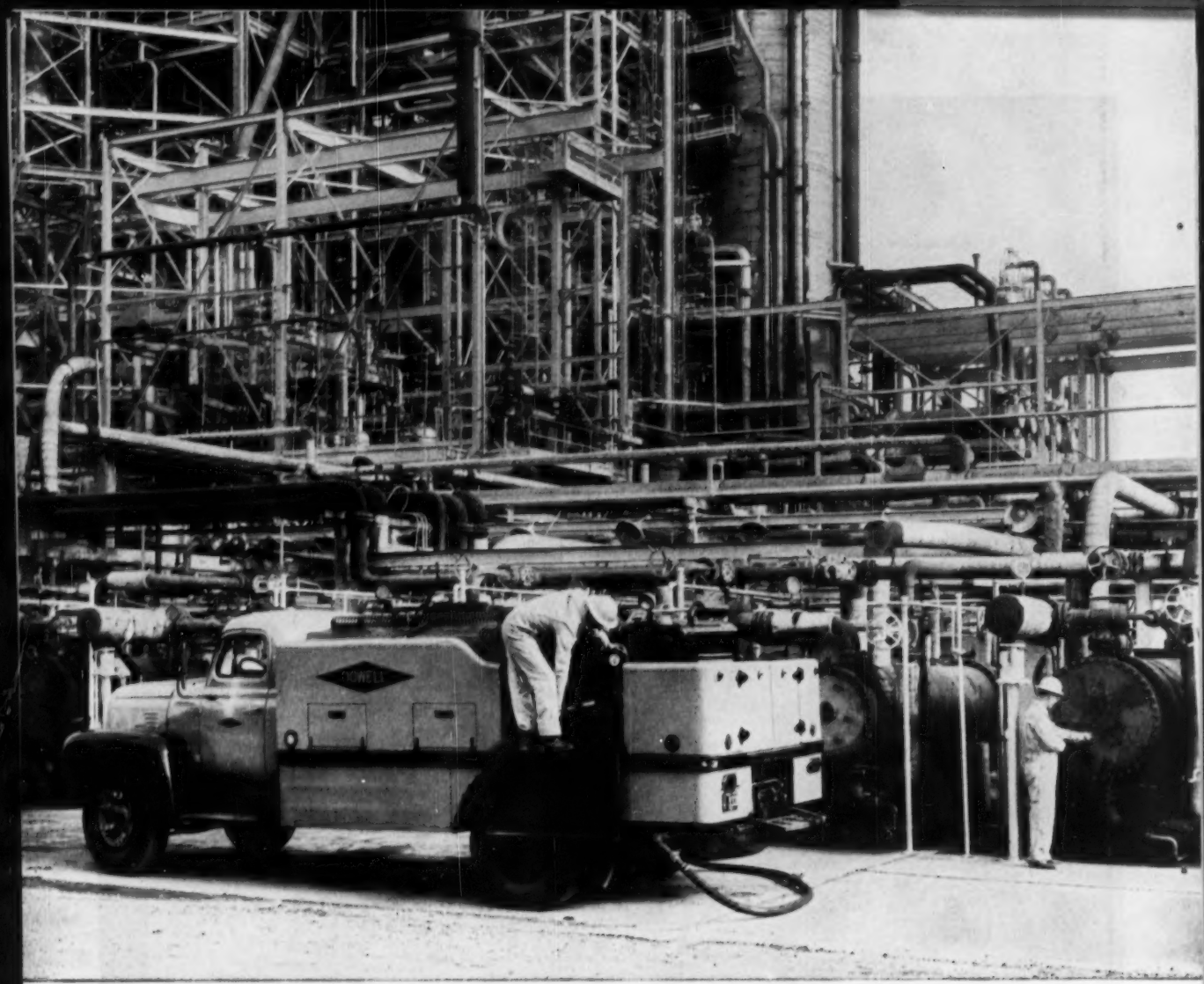
Our experienced technical service staff will be glad to help you with your gas scrubbing problems. For prompt service, call your nearest Jefferson representative. **Jefferson Chemical Company, Inc., Box 303, Houston 1, Texas.**

Essential Chemicals from Hydrocarbon Sources

Jefferson
CHEMICAL COMPANY, INC.

Ethylene Oxide, Glycols, Dichloride
Ethanolamines
Nonyl Phenol
Morpholine
Ethylene, Propylene and Glycerine Carbonates
Polyethylene Glycols

HOUSTON • NEW YORK • CHICAGO CHARLOTTE • LOS ANGELES



While the cat cracker remained in full operation, DOWELL cleaned six slurry exchangers chemically . . .

UPPING THROUGHPUT 900 BPD

No cat cracker operator wants to see his throughput go down. Neither did this one. Nor could he afford to wait for the annual shutdown to give six slurry exchangers the cleaning they obviously needed *fast*. His solution? Call Dowell to remove the scale deposits with chemicals.

Dowell engineers devised a procedure for cleaning the exchangers *with the cat cracker in full production*. The exchangers were cleaned by Dowell one at a time, while the remaining five units carried the load.

As a result of chemical cleaning, the operator reported a jump in throughput of *900 barrels per day* . . . plus an average increase of 26° in the heat co-efficient of the exchangers.

Dowell Service is designed to restore *your* equipment to top efficiency—and do it *fast*, with the very minimum of costly downtime. Experienced Dowell engineers do the job for you. They bring all the necessary chemicals, pumps and control equipment right into your plant. Solvents are introduced through regular connections, holding dismantling to a minimum.

For full information on a program of Dowell chemical cleaning for *your* plant, call your nearest Dowell office. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. B-31.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

A Quick Look at the Industry THIS MONTH

Petroleum REFINER
February, 1956

All-industry outlook: Production and demand will come down from stratosphere, with auto industry leading the way. Construction will jut skyward with 15 percent jump to $32 billion. Result: Small boom compared to big boom of '55.

Oil industry outlook: Production and demand will resume normal growth pattern. Crude runs to stills will hit new peak with 3.6 percent increase to 7,746,000 barrels daily. Reason: 4.5 percent boost in domestic demand for refined products.

Total demand will increase 3.9 percent over '55 despite 9.5 percent decrease in exports. Refined product imports will increase 7 percent.

—•—

Study in contrast: Auto industry expects to produce more than a million less cars in '56—6.5 million. Steel should reflect this drop more than any industry. Instead, plans are in effect to add 5 million tons to nation's steel-making capacity this year, with 10 million more to come. Continued construction and population booms are major factors.

—•—

Rapid growth of petrochemical and synthetic rubber industries gives solid basis for steel's optimism. Dow Chemical expects to spend $75 million on new construction in '56—U. S. Rubber, $36 million. Other companies (Phillips, Monsanto, Firestone, etc.) are following suit—all planning construction increases over last year.

Rubber industry predicts it will use 1,500,000 long tons of new rubber this year—about the same as '55.

—•—

Refiner's octane race is rivaling auto makers' horsepower scramble. Latest report shows 53 U. S. and Canadian cities average 95.5 octane for premium gas and 88.1 for regular. Six cities average 97 octane or higher for premium and five have 91 or higher for regular. Little Rock, Ark. is the premium champion—97.5 octane. New York took honors for regular—91.9.

—•—

Look for new oxidation process in manufacture of phthalic anhydride, terephthalic acid and other polybasic petroleum chemicals. Standard (Indiana) has a process in pilot plant stage that is expected to simplify conventional techniques and give better yields—higher purity of product.

Polyethylene producers are still beating a trail to the Southwest despite growing rumors about building ethylene plants in the East. Plentiful supply, low cost and cleanliness of natural gas fuel are irresistible lures for manufacturers. Look for many of newer entrants into polyethylene field to locate in Gulf Coast area.

—•—

1956 will be best yet for chemical engineers. Expansion plans in research, development, process design and production will use up this year's graduates—with openings left over. June grads will start at about $400 in all phases but production where beginning wages will run $20-$40 a month less.

—•—

The urge to merge continues. Since 1948, 32 oil and gas companies have been absorbed by 21 others. Latest is Atlantic Refining's merger with Houston Oil. Tightening of anti-merger laws is seen in not-too-distant future.

A Quick Look at the Industry (continued)

Midst talk about atomic energy competing with oil, a darkhorse enters the picture—solar energy. Experts are discussing ways in which sun-harnessing can supplement fossil-fuel resources. A solar furnace is being used to produce refractory materials in France—India and Jerusalem are using the sun to purify water. Most-talked-about use is for home heating and air conditioning. Major drawback to date is initial cost.

—•—

Use of models for engineering-contracting is growing fast. One engineering firm uses models on 80 percent of its jobs. Though clients sometimes determine the detail, the models are made to help contractors—not just to curry favor of customers.

—•—

Interest in liquefied natural gas is picking up. Reason: Reports that Conoco has about completed research in liquefaction. Big potential here is buying up cheap gas (like Middle East or Venezuela fields) and transporting it to fuel-hungry areas or petrochemical plants. Holdup now is development of storing and shipping—mostly mechanical problems.

—•—

Round one in battle for power between AFL-CIO and independent oil unions goes to the independents. Standard (Indiana) employes gave the big snub to AFL-CIO's Oil, Chemical and Atomic Workers by whopping 4-1 vote. Campaign to wed independent oil unions will move forward in February.

—•—

Every month brings new orders for jet planes. American engine manufacturers are now capturing some bids which were going to Britain. Latest orders for turbo-props: Eastern, 40 in 1958; Braniff, 9 in '59; and Continental, 12 in '58. It all spells out a rapid increase in passenger miles by air—U. S. airlines expect a 15 percent increase in '56.

Prediction: In spite of Armed Services complaint about shortages in residual fuel and avgas on the West Coast, industry will come through with full coverage by June 30.

—•—

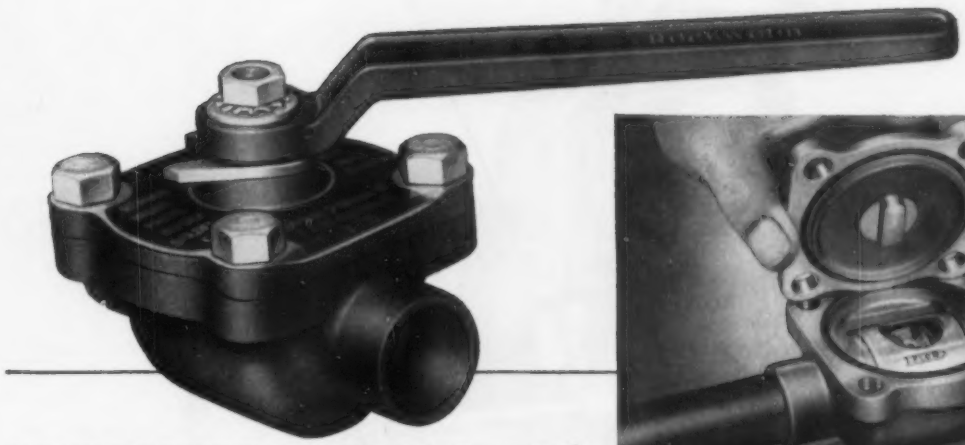
Air pollution-plagued cities may soon have a respite—at least from fume-throwing auto mufflers. Latest announcement from L.A.'s Air Pollution Control District describes a design which cuts down hydrocarbon emmissions 97 percent and carbon monoxide 81 percent.

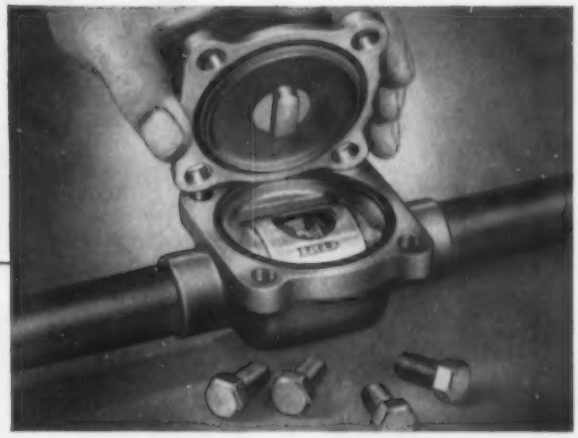
—•—

Some auto engineers are still cool about gas turbines. Though all of the Big Three have experimental models, none have announced plans for production. GM's latest model displayed in January burns kerosine but its economy is no more than conventional piston engine.

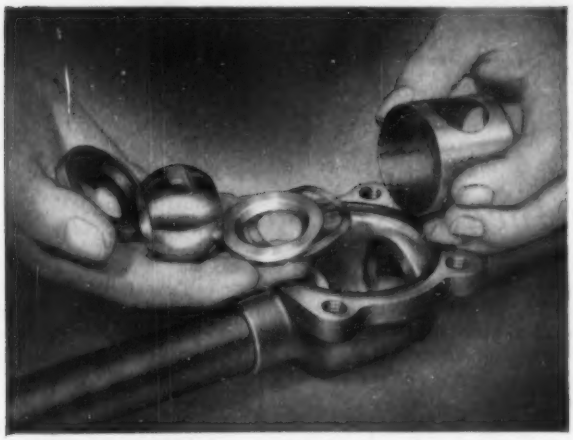
—•—

December wildcatting netted 69 new oil fields. Most were moderate to small in importance, but five of the better looking discovery wells were: Texas Crude's Ector County, West Texas, discovery flowing 2878 barrels of 34-gravity oil daily; a 1320-barrel, 38-gravity, oiler in Ochiltree County, Texas Panhandle, by Woodson Oil; Drilling & Exploration's discovery in Dawson County, West Texas, that flowed 902 barrels of 37-gravity oil; Sinclair's Lea County, New Mexico, find good for 792 barrels of 42-gravity daily; and Humble's strike in the same county that potentialed 454 barrels of 44-gravity oil per day.





FAST, LOW-COST CHANGE IN DIRECTION OF FLOW. Removal of the body cap permits reversing the cage assembly to allow change in direction of flow. In addition, this feature lets you change seat material, and clean the valves thoroughly and quickly — *without removing the valve from the line!*



INTERCHANGEABILITY of seat material to meet your operating requirements is another feature of the Rockwood Top Entry Ball Valve. Seat can be furnished in Buna-N, Neoprene, Kel-F, Teflon, and Nylon.

EASY INSTALLATION AND OPERATION is permitted because of the new handle design. This new design allows the handle to be placed in any of *eight positions!*

Now!... New Rockwood Top Entry Ball Valve

. . . A new concept in valves that saves you money and time!

Made of bronze the new Rockwood Top Entry Ball Valve is ideal for handling oxygen and hazardous liquids as well as water, oil and gas. It carries 300 lbs. per square inch on water, oil and gas and 400 lbs. per square inch on LP gas and is available both with sweat ends and screw ends, in sizes ½", ¾" and 1".

Write for complete data on this unique full round pipe size flow.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

Distributors in all Principal Industrial Areas

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
789 Harlow Street
Worcester 5, Mass.

Please send me complete information on Rockwood Top Entry Ball Valves.

Name.....

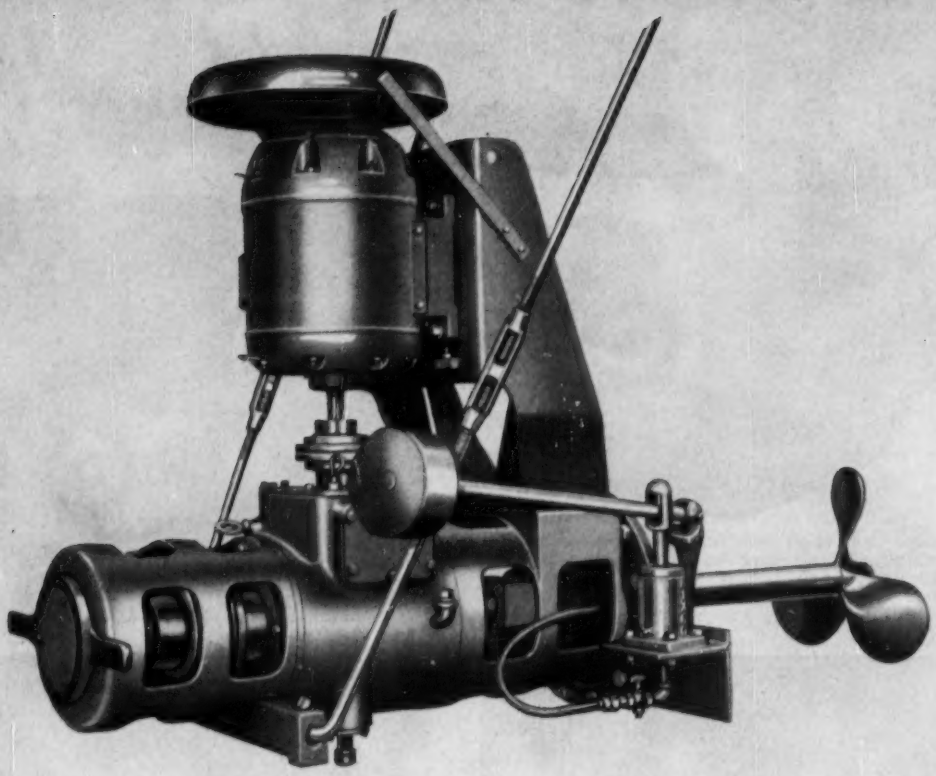
Title.....

Company.....

City.....

Zone.... State.....

For more data on advertised products, use Readers' Service Cards, last page.



This is the mixer **you** *helped design*

You wanted a big-tank mixer that would mix fluids fast—to complete uniformity. But that wasn't nearly enough.

You wanted a mixer you could *forget.* A mixer that would run year in, year out, with the barest routine attention.

You first told us about the need for a shaft bearing that wouldn't have to run submerged in the tank liquid.

That's when we put *ball bearings* in LIGHTNIN Mixers—and moved the bearings back *out* of the tank, away from grit and trouble.

You didn't want to be bothered aligning the mixer when you put it on the tank. So we housed the LIGHTNIN in three rigid castings, joined with concentric rabbet fit that can *never* get out of line, no matter what.

You wanted the gears protected from unusual shock loads—as might happen if the propeller whacked a ladder or other obstruction in the tank. We found the answer for you—in *hollow-quill drive* that isolates the gears from the shaft, protects your investment with a flexible coupling between shaft and gearing.

You wanted to repack the mixer stuffing box quickly—without having to figure out where to put 180,000 barrels of product while repacking. We developed the LIGHTNIN shutoff device that pulls the shaft back like a valve stem, sealing the tank so you don't lose even a pint of product. And we put *handles* on the shutoff because your maintenance men like it that way—out in the open, easy to get at.

But then you got to wondering about the stuffing box itself. Would a rotary mechanical seal do the job better? What about *replacing* the seal, if it ever wore out?

This time, your quest for something a little better *really* paid off. Now you can get a LIGHTNIN Mixer that runs for years *without repacking or adjustment.* No stuffing box. No leakage around the tank. And should the LIGHTNIN Seal ever wear out, you can replace it in *minutes.* No dismantling. No unhitching the mixer from the tank. *No need for special skill.* It's saving oil companies thousands of dollars a year in upkeep!

Thanks to your telling us what you like—and don't like—in a mixer, hundreds of LIGHTNINS have been in service for more than 25 years. More than ever, today's LIGHTNINS meet your needs realistically, in every respect. More reasons than ever before to put LIGHTNINS on *your* big tanks.

For quick, knowing help on fluid mixing, call your LIGHTNIN representative. (He's in Refinery Catalog.) Or write us.

Lightnin® Mixers

MIXCO fluid mixing specialists

CUT MIXER MAINTENANCE 60% with this new LIGHTNIN cartridge-type rotary seal—optional with LIGHTNIN Mixers. It runs for years without adjustment—and slides off the shaft for fast, easy replacement if ever necessary.

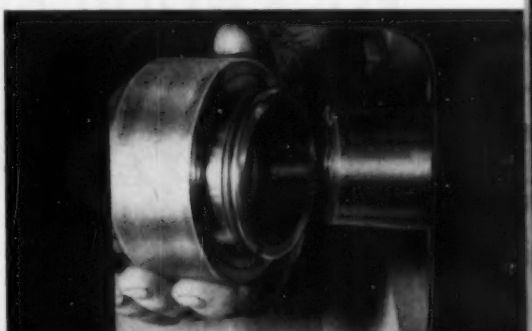
FOR LATEST MIXING INFORMATION and full description of LIGHTNIN Mixers, send for these helpful bulletins:

- ☐ B-102 Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP
- ☐ B-103 Top entering; propeller types: ¼ to 3 HP
- ☐ B-108 Portable: ⅛ to 3 HP
- ☐ B-104 Side entering: 1 to 25 HP
- ☐ B-112 Laboratory and small-batch production types
- ☐ B-110 Condensed catalog showing all types
- ☐ B-111 Quick-change rotary mechanical seals for pressure and vacuum mixing
- ☐ B-107 Data sheet for figuring mixer requirements

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc. 164-b Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.



Chemical Imports—Are They a Threat?

AS TARIFF CUTTING talks gets underway at Geneva, let's actually take a look at chemical imports. Will increased chemical imports threaten U. S. Mobilization efforts? We think not . . . and here's why.

Taking a few of the "key defense chemicals" and analyzing the past vs. the present will illustrate the trend. For the period of January-August 1954 and the same period in 1955 Acetic Acid production increased from 279 million pounds to 347 million pounds in 1955. Imports for this chemical during this period in 1954 were 1 million pounds and for 1955 1.7 million pounds. Exports were 0.2 million pounds during this period in 1954 and 0.5 million in 1955. Both imports and exports increased for these periods but production also increased. Comparing the imports of 1.7 million pounds with the production of 347 million pounds shows that **imports** are very small indeed.

This same trend is true for other chemicals such as methanol, carbon tetrachloride, and phthalic anhydride. In the case of methanol, imports are really small but exports are sizable—in the neighborhood of 4 percent of production. The same applies to Phthalic Anhydride with its exports being almost 6 percent of production for the analysis period.

Generally world trade in chemicals **is on the** increase. Exports of chemicals from the U. S., on the upswing, is expected to increase. Imports of chemicals into the U. S., too, is trending upward but the increase should be at a more gradual rate than exports. Estimates for 1955 gave chemical exports as $3.7 billion and imports as $2.4 billion.

These import-export figures for chemicals compares with the second quarter (1955) total trade report as follows: Imports $20 billion and exports $21.5 billion. Thus it would seem that chemicals amount to about 5 per cent of U. S. export-import trade.

For the world economy to continue to expand. more free world trade is indicated. Greatest increase in U. S. exports in 1955 was to Free Europe and included many items to sustain their industrial boom. Chemicals were among these items. The rate of increase in world trade will depend upon many things not the least of which is U. S. attitude and actions about tariffs.

Many U. S. chemical manufacturers will state quite frankly that they can't compete with the cheap labor abroad. On the surface this statement is correct but he should say that he can't compete with the unit production costs of other countries before requesting protective tariffs.

Take West Germany, for example. The German chemical industry is growing very rapidly in comparison with other industry. For example since 1953 their plastics industry has increased production almost 25 percent each year until the 1955 production was about 754 million pounds. This increase was supported by increased exports. About 25 percent of this plastic production was exported with the principal proportion going to Asia and into other areas not usually served by the U. S.

Labor costs in other countries are difficult to compare when using only the wage rates as a factor. The actual wage rates do not indicate the labor costs per unit of production. The first item to consider is that the amount of labor required per unit of production in a foreign country is higher than in the U. S. This is because the rate of production per worker is smaller. The number of production workers for any given output is greater in the U. S.

For example one large company in Germany has four plants with a total employment of approximately 4100 workers. The gross sales of this German company was approximately $280 million in 1955. This compares with an average U. S. company of 2500 employes having a gross sales of $600 million. The U. S. manufacturer does more than twice as much business with almost half as many employes.

The German chemical manufacturers are stuck with a lot of *inefficient* plants and processes. During the 1939-45 period their war effort demanded greater production from the chemical industry than ever before. The chemical companies were forced to expand their operations based on acetylene chemistry. The raw materials used for all chemical production were coal and limestone. These raw materials are not suited for some of the present high demand chemicals when they must compete in a peace time free trade market. The machines and methods of production are not as efficient as those used in the U. S.

In countries recovering from the effects of losing a war, the "voluntary social contributions" for retirement plans and social security programs must be built back and this taxes the industry to a great extent. The workers in West Germany for example are emulating the U. S. worker more and more. The standard work week in Germany has been 48 hours. This will be changed by some of the chemical industry this year to 45 hours and given as another "social benefit."

Along with this shorter work week (with the same take home pay as the previous 48 hour week) comes a 7-10 percent wage increase. Since 1951 German workers in the chemical industry have had wage increases amounting to 30 percent as compared with the U. S.

Unsuspected copper may be causing your gasoline to form GUM

When your gasoline leaves the refinery, it may not contain a trace of copper . . .

But pump-island surveys show that most gasolines pick up some copper before they reach your customers' car tanks. And copper in concentrations of less than one part per million can catalyze the gum-forming reactions to a harmful level. One Du Pont gasoline quality survey, for example, disclosed significant amounts of copper present in 91% of 241 gasoline samples from representative service stations in the U.S. and Canada. And the gasolines known to contain no metal deactivator were found to be high in gum content.

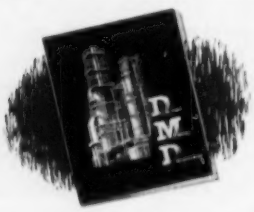
The results of this survey indicate clearly that, in spite of the great pains taken to prevent copper contamination during refinery operation, copper is getting into the majority of gasolines sold. How? . . . Probably from contact with valves, pumps and other sources in the distribution system.

You CAN control it

Only about 1 pound of Du Pont Metal Deactivator (DMD) per 1000 barrels is needed to safeguard your gasolines against the harmful effects of copper. And in this low concentration, it costs you less than ⅛ of a cent per barrel to get this effective and important quality insurance.

DU PONT METAL DEACTIVATOR also has valuable applications in kerosines, jet and diesel fuels, furnace and turbine oils.

Ask for a sample and prove to yourself its effectiveness. Or ask one of our regional laboratories to evaluate it for you, in your own stocks. Just address your request for this service to the nearest sales office listed below.



Write for booklet—All of the properties, uses and methods of addition of DMD are discussed in this booklet. If you do not already have a copy, ask any of our representatives or sales offices to send you one.

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living . . . through Chemistry

Petroleum Chemicals

Sales Offices: **E. I. DU PONT DE NEMOURS & COMPANY (INC.)** • *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

CHICAGO, ILL.—8 So. Michigan Ave. ..... Phone RAndolph 6-8630
HOUSTON, TEXAS—705 Bank of Commerce Bldg. . Phone CApitol 5-1151
LOS ANGELES, CAL.—612 So. Flower St. ..... Phone MAdison 5-1691
NEW YORK, N. Y.—1270 Ave. of the Americas . . Phone COlumbus 5-2342
PHILADELPHIA, PA.—3 Penn Center Plaza ..... Phone LOcust 8-3531
PITTSBURGH, PA.—Room 510, Alcoa Bldg. ..... Phone ATlantic 1-2933
SAN FRANCISCO, CAL.—Room 626, 111 Sutter St., Phone EXbrook 2-6230
SEATTLE, WASH.—Room 215, 4003 Aurora Ave. ... Phone MElrose 6977
TULSA, OKLA.—P. O. Box 730 ..... Phone LUther 5-5578

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division—80 Richmond Street West—Toronto 1, Ontario
OTHER COUNRIES: Petroleum Chemicals Export—Nemours Bldg., 6539—Wilmington 98, Delaware

For more data on advertised products, use Readers' Service Cards, last page.

chemical worker's 21 percent for the same period. Social contributions may amount to as much as 250 percent of the U. S. manufacturers while contributions to pension plans and such may exceed U. S. manufacturers by 30 percent. While the German chemical worker only receives $0.50 per hour these hidden and overhead costs make this equivalent to $2.20 per hour in the U. S.

The entire German industry has always been export minded. This has caused neglect of the home market. This picture is changing now that there is a boom in the West German automobile industry. While a number of these cars are intended for export there is heavy demand in the home market. The boom can be supported by this local demand. The U. S. is exporting coal, steel and chemicals to support this boom. As the standard of living improves, brought on by this industrial boom, the German people will demand more of this production for their own consumption.

In Germany, the chemical industry has been based on acetylene chemistry because of the raw materials that were available. Today they are intensively interested in ethylene chemistry. They are importing know-how and processes from the U. S. This will be a very expensive change over for the German chemical industry.

Most of the petroleum consumed in Germany is imported. Exploration is being conducted with feverish intensity. When a gas field is discovered, the production is used entirely for chemical production and none of it is used for fuel.

In spite of these handicaps the German chemical industry is making a strong come-back. Their methods of research and education enable them to contribute to the fundamental knowledge of the industry. America's greatest contribution is in field of chemical engineering. By applying the best chemical engineering know how to the German fundamental ideas both Germany and the U. S. should profit mutually.

Therefore, the threat of chemical imports to the U. S. appears very slight. The ability and desire for the countries outside the U. S. to supply the newly demanding home market is increasing. The general world wide rise in living standards is further conducive to home consumption. The defense efforts of the free nations of the world should keep U. S. production and exports high for several years. Until the foreign countries improve or increase their production of chemicals the U. S. should export more than it imports.

Simple Procedure For Oil People

WHOSE JOB IS IT to see that the oil business has a better understanding at the hands of the public? Is it just the job of the American Petroleum Institute and its committees? Is it just the job of the company executive who may be a heavy stockholder—or who may not be but who has an interest in keeping a good job?

No, the responsibility goes far deeper than that. It goes to every individual who works in the oil business whether he works out in the oil fields, in a refinery, on a pipe line or works at a pump in a filling station.

If he intends to stay in the oil business then he had better do everything he can to help the oil industry get and maintain a good name at the hands of the public. His job is liable to be just about as stable as is the reputation of his industry.

How can you, or anyone employed in the oil industry help it to secure and maintain a good name?

The answer to that is easy:

1. *So conduct yourself in all of your operations as an oil man in contact with the public that the public will feel "that's a good oil company to do business with."*

2. *If you hear somebody making a statement about the oil industry which your own information tells you is untrue, correct it in a friendly manner.*

It is just as simple as that. If the more than million employes of the oil industry in the United States will just do these two things, greater results will be had than can be expected from a multi-million dollar advertising campaign.

And just as we said on this page recently, "this is not a job for just a week in the year—it is an every day job 365 days in a year."

Gasoline and Fuel Stocks Improved

THE PAST MONTH brought considerable improvement to refined oil stocks situation. Heavy drafts on distillate fuel oils completely eliminated the previous tendency of these fuels to accumulate excessively. At the same time gasoline inventory growth slowed down as relatively small additions were made for this time of the year.

These favorable conditions resulted from the combination of weather and adjustment of refinery yields. Cold weather, in many parts of the nation, stepped-up sharply the use of the heating oils. Meanwhile, refineries were increasing thruput, but yields were adjusted to emphasize manufacture of fuel oils without greatly increasing motor fuel output.

Gasoline stocks on January 20, 1956, totaled 175¾ million barrels, which was 9½ million barrels more than was on hand a year earlier. This relationship was only slightly higher than that which existed in mid-December, when stocks were 8⅔ million barrels greater than previous year level.

Motor fuel stocks increased rapidly between November 1 and mid-December, and the indication was that they could become excessive by winter's end. First of November's stocks had held a 2-million barrel margin, and this promptly built up to the 8⅔ million figure. A continuation of that trend would probably have caused unfavorable results to the industry. Consequently, the holding of these inventories nearer to previous year's level is highly encouraging.

Stocks of distillate fuels are now in fine condition. On January 20, these inventories totaled about 94½ million barrels, 1¼ million barrels less than in 1955.

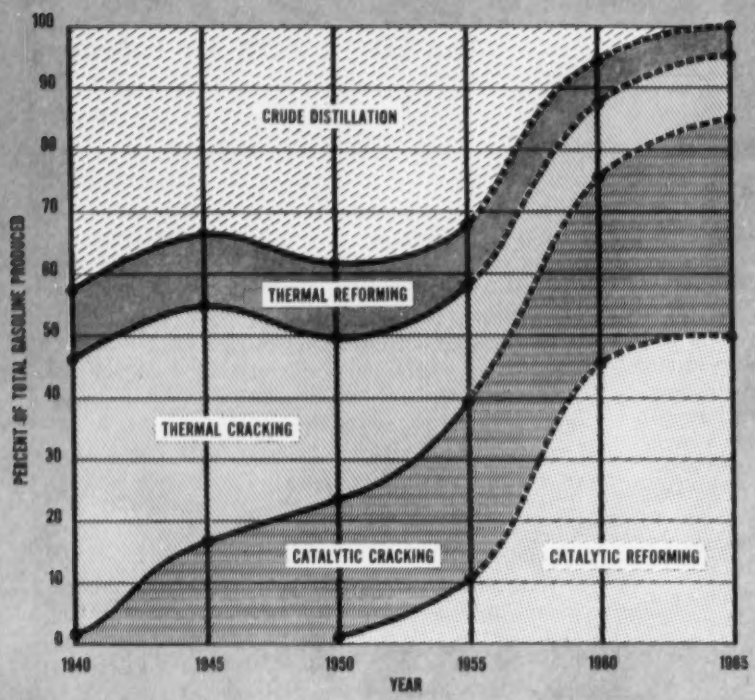


FIG. 1. Trends in processes for making gasoline. By 1965 catalytic reforming may account for 50% of all gasoline.

How to get your top octanes more economically

By HAROLD J. GIBSON
Ethyl Corporation, Detroit, Michigan

WITH the growing trend to better-grade gasolines, the cost of producing those last few octane numbers has steadily increased. As a result, refiners are looking anxiously for more economical ways to get their top octanes.

Already octane numbers in the 97 to 98 range are being marketed in the East and Southwest. And the trends for all U.S. refineries in terms of pool, regular and premium fuels show that octane numbers are continuing a slow, steady rise each year.

To meet the demand for higher-octane fuels, refiners are being constantly forced to change their processes. A look at the graph at the top of the page (Fig.1) will show you the gradual changes in process evolution. Note that by 1965 catalytic reforming may account for 50% of the total gasoline production in the industry.

Depending on the specific octane-improvement problem, the economic answer usually consists of a combination of tetraethyllead and various processing steps. (Some of these processing alternatives are displayed in Fig. 2.) The question becomes: How to determine the most economical way to get those top octanes. Only by conducting a detailed economic analysis can a refiner be sure of finding the best solution for his refinery, for from an economic analysis he can determine the proper balance between lead and a processing alternative.

An economic analysis will take into consideration all of the factors that affect the costs of making your gasoline: for example, optimum rates and yields, raw-material costs, product prices, operating manpower, maintenance and repair, utilities, depreciation, investment charges and reasonable "pay out."

TABLE 1. Estimated Pool Octanes and Premium — Regular Octane Numbers

		With 2.2 ml/gal TETRAETHYLLEAD	With 3.0 ml/gal TETRAETHYLLEAD
At the end of 1953	Pool	88.0	89.4
	Premium	92.9	94.3
	Regular	85.9	87.3
At the end of 1954	Pool	89.3	90.7
	Premium	94.2	95.6
	Regular	87.2	88.6
At the end of 1955	Pool	90.8	92.1
	Premium	95.7	97.0
	Regular	88.7	90.0

Octane improvement analyzed

From such an analysis you can determine the economics of octane improvement, which is the tool for obtaining the optimum sequence of processing steps and attendant use of tetraethyllead. Analyzing octane improvement costs calls for a thorough understanding of unit operating costs, particularly when incremental expenses are being considered.

There are several approaches for analyzing the costs of octane improvement at higher levels. At Ethyl we have found, through our studies of the economics of top octanes, that the key to cost analysis is a value called *incremental cost*. Simply expressed, this is the rate at which costs increase as you raise the octane number. It can be expressed conven-

For more data on advertised products, use Readers' Service Cards, last page.

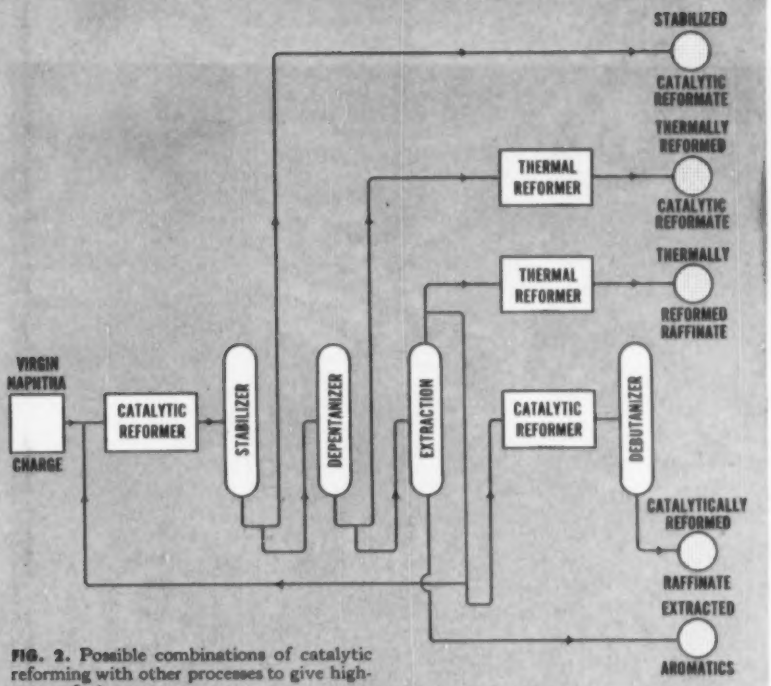


FIG. 2. Possible combinations of catalytic reforming with other processes to give high-octane fuels.

iently in cents per Research octane number per barrel. (¢/RONB).

Once you determine incremental costs, the next step is to make sure you are employing the best possible process at each point. By plotting the cost curves on a chart, you will see that up to a point the cheapest way to improve gasoline is with lead. Then lead becomes closely competitive with mild reforming methods.

After you reach an incremental cost of about 5¢/RONB, it again is definitely cheaper to add tetraethyllead. And finally when the full 3 cc of lead is used, you must return to reforming—this time at greater severity.

Today there's a greater trend toward using lead in higher concentrations for, as one industry spokesman put it, "tetraethyllead has decreased steadily in price while the costs of refinery construction have continued to rise rather sharply."

With constantly increasing gasoline-quality demands facing the refiner, it has become increasingly important to define the optimum route to high-octane fuels. Lead addition now costs an average of 4 to 5 cents per Research octane number per barrel, and this is directly competitive with the cost of mild reforming operations for octane improvement. As product octane levels increase, refiners may have the choice of using maximum tetraethyllead—3 ml/gal—or going to more expensive reforming operations—more severe single pass reforming or extraction followed by raffinate reforming. Here—even though lead susceptibility decreases somewhat in aromatic reformates—the cost of octane improvement by lead becomes increasingly more attractive as compared with various processing alternatives. Where extremely high octane levels are required, a refiner has little choice but to use the more economic tetraethyllead to the maximum and then to vary his processing alternatives to give the desired product quality if he wants to hold his manufacturing costs to a minimum.

KNOW THIS EQUATION?

$$¢/RONB = \frac{(Y-100-F)(Pg-9.4T) + Pb(F+G) + Pf100\,H - 100\,E}{100\,RONp - 100\,RONn - 10F + Y(RONr - RONp)}$$

You should if you are making an economic analysis. Write for a copy of a recent 50-page report giving a definition of terms of this equation and other information on new processing alternatives and on the economics of top octanes. Address your request to Department No. 24, Ethyl Corporation, 100 Park Avenue, New York, New York. No charge. (Advertisement)

HOW Ethyl Research can help you

Our Refinery Technology staff, backed up by the extensive facilities of the Ethyl Laboratories, will be glad to share their experience with your economics people when you conduct a cost analysis of your top octanes.

We will work with you, or if you prefer, we are even equipped to do a complete cost analysis for you.

We can help you answer these and other questions: When should you use "Ethyl" antiknock compound in preference to increasing the catalytic reformer charge rate? How does increased severity of reforming affect your costs? When should you carry your tetraethyllead content to the maximum allowable—and under what circumstances?

Your Ethyl Representative will be happy to arrange an appointment for you with one of our Refinery technologists.

ETHYL CORPORATION
Research Laboratories

1600 W. Eight Mile Road, Ferndale 20, Mich
2600 Cajon Road, San Bernardino, Calif.

For more data on advertised products, use Readers' Service Cards, last page.

General Petroleum Corporation, Socony Mobil's West Coast affiliate, built the first full-scale oil refinery in the Pacific Northwest at Ferndale, Wash. The refinery was completed in 1954 at a cost of $38 million.

The Postwar Decade Marks . . .

Socony Mobil's Greatest Expansion

In the ten years from 1946 through 1955 Socony Mobil's construction program increased refinery output 68 percent.

THE POSTWAR decade, 1946-1955, has seen the greatest expansion, reconstruction, and improvement of the worldwide refining facilities of Socony Mobil Oil Company, Inc., of any similar period in the company's history.

Since shortly after the end of World War II the crude runs of Socony Mobil's wholly owned refineries in the U. S. and abroad have risen from 400,000 barrels a day to more than 670,000 barrels a day—an increase of 68 percent.

In addition, Socony Mobil's 50-percent-owned subsidiary, Standard-Vacuum Oil Company, whose refineries were inoperative at the end of the war, is now operating six refineries with a total crude capacity of 160,000 barrels a day. Standard-Vacuum operates in South and East Africa, South and Southeast Asia, the Far East, and Australia and New Zealand.

Through its interests in Iraq Petroleum Company, Arabian American Oil Company, and the consortium in Iran, Socony Mobil also shares in the output of the Middle East refineries operated by these companies. At Sidon, Lebanon, the Medreco refinery, jointly owned by Socony Mobil and Caltex, started operations in February 1955.

In Western Europe refinery construction and rehabilitation during the postwar period played a major role in the rapid industrial comeback of that area. By the end of the war, Socony Mobil had lost five small refineries in satellite countries—two in Yugoslavia and one each in Czechoslovakia, Poland, and Rumania—and its refineries elsewhere in Europe were so badly damaged that complete reconstruction was necessary in most cases. Between 1945 and 1955, however, crude runs at the company's Western European refineries rose from less than 15,000 barrels a day to 132,000 barrels a day.

This is another in the PETROLEUM REFINER'S series on postwar refinery construction and rehabilitation. Next month, Socony Mobil's 50 percent-owned subsidiary Standard-Vacuum Oil Company will be covered.

The Naples refinery of Socony Mobil's Italian affiliate was a gutted ruin when the war ended and by the end of 1945 only 5000 barrels a day of crude capacity had been restored to operation. Today it is a modern 65,000-barrel plant.

The Bremen refinery of the company's German affiliate and French

refineries at Frontignan and Gravenchon also were severely damaged. All three have since been rebuilt and modernized.

During the postwar decade Socony Mobil has added one completely new refinery overseas—at Coryton, England. This plant, opened in 1954, has a crude capacity of 25,000 barrels a day but is now running above capacity. Besides an Airlift Thermofor Catalytic Cracking (TCC) unit, its major features include a modern lubricating oil plant.

Construction of the Coryton refinery is a classic example of overcoming difficulties of site location. The site on the Thames River estuary was below high water level—a mile long and half a mile wide—and completely surrounded by water. It took three years, a peak force of 4000 men, 40,000 tons of foundation concrete, 13,000 piles to support various structures, and half a million tons of gravel to transform marshland into a major industrial plant.

In addition to the five major European refineries of Socony Mobil's wholly owned affiliates in Great Britain, France, Germany, and Italy, the company operates a 2900-barrel plant at Kagran, Austria.

In the U.S. Socony Mobil's crude runs rose 40 percent in the first postwar decade—from 386,000 barrels a day to a present total of 541,000 barrels a day. Although the percentage increase was smaller than in Europe, the construction effort required to meet the unexpectedly large rise after the war in domestic demand for petroleum was considerably greater than abroad. And the postwar need for new refining facilities was made more urgent by the wartime restrictions on normal expansion and replacement, as well as by the competitive demand for improvement in product quality.

Socony Mobil and its domestic affiliates—Magnolia Petroleum Company in the Southwest and General Petroleum Corporation on the West Coast—now operate 12 refineries in this country. During the postwar period the company has erected one new refinery—at Ferndale, Washington—and has closed down small plants at Long Island City, N. Y.; Lebec, Calif.; Olean, N. Y., and Fort Worth, Tex.

The Ferndale plant, which went on stream late in 1954, was the first full-scale refinery to be built in the Pacific Northwest. A $38 million project, this 35,000-barrel plant is located on an 850-acre site on Puget Sound, 15 miles south of the Canadian border. A spur line into the refinery connecting with the Trans Mountain pipeline a few miles above the border makes it possible to receive crude from Canada's western provinces.

During the immediate postwar years a number of improvements in Socony Mobil's TCC process—which played an important role in producing high-octane aviation gasoline during World War II—were incorporated into completely redesigned units. In 1950 the company began an extensive program for replacing the original fixed-bed Houdry units with more efficient Airlift TCC units. Two such units were built at the company's largest refinery, at Beaumont, Texas, in 1950, and three more were completed elsewhere the following year.

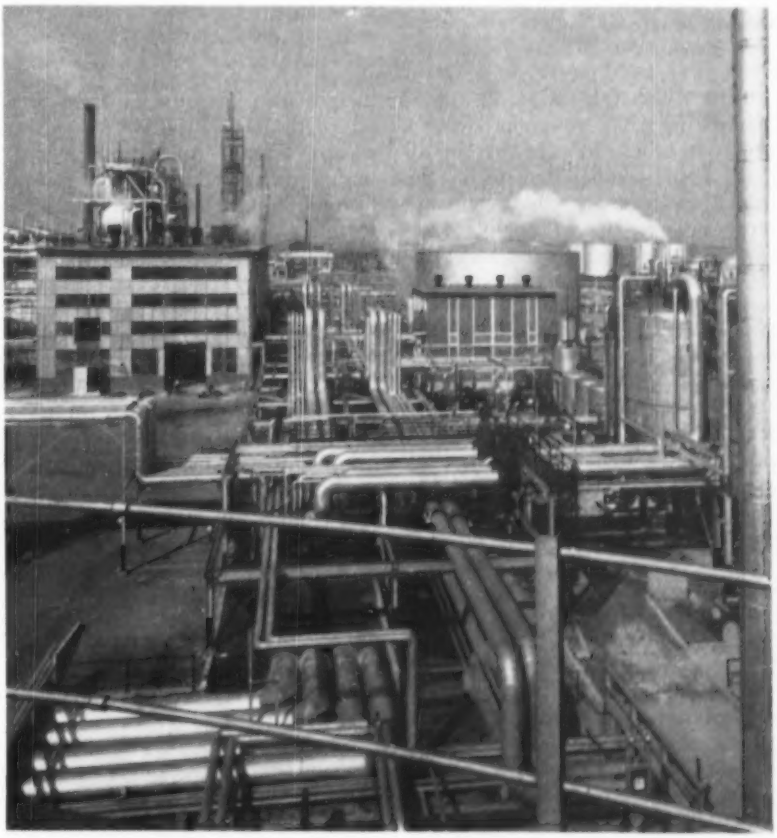
TCC units have now been installed at all of Socony Mobil's domestic refineries except the Providence, Rhode Island, plant. All except two of these refineries—Torrance, Calif., and Casper, Wyo.—have TCC units of the Airlift type.

The first Airlift TCC unit to be constructed at the company's overseas refineries was completed in 1951 at Frontignan. Another went on stream at Bremen in 1952, a third at Coryton, in 1954, and a fourth at Naples last year.

Since the first units of this type were put into operation, a number of design improvements in the catalytic section have made possible an almost 40 percent increase in throughput capacity, as well as important savings through reduced bead catalyst consumption.

The silica-alumina bead catalyst developed by Socony Mobil for use in the TCC process is manufactured in a catalyst plant at Paulsboro, N. J., operated in conjunction with the company's principal eastern refinery. In 1952, the capacity of this plant

Continued on Page 200



Boiler and power plant at the Coryton, England, refinery of Mobil Oil Company, Ltd., British affiliate of Socony Mobil. The refinery was opened in 1954.

THESE YOUR PROBLEMS ?	O.R. WOULD USE...
Product Blending	Linear Programming
Economic Batch Size	Inventory Control
Production Control	Servo-Mechanisms
Spare Equipment	Queueing Theory

This Is Operations Research

Here's an introduction to some of the interesting techniques of OR.

Merrill M. Flood
Columbia University, New York, N. Y.

THE NEWCOMER to operations research normally insists on having a definition of the term before he will read about accomplishments in the field. He expects something new and revolutionary. He is usually somewhat disappointed, for he soon discovers that OR represents nothing more than a name for the postwar increase in the quantity and quality of scientific research on industrial management and operating problems.

If he is experienced in some older area of engineering or business analysis, such as industrial engineering, statistical quality control, systems engineering, engineering economics, business statistics, traffic engineering, scientific management, or market research, he is pretty sure to conclude that he has been doing operations research all along. In fact, he probably has been, if he has used the three basic companion techniques of modern science: formal hypothesis, careful test, and valid generalization.

OR is a thriving new field both in American industry and abroad.[1] Many companies have established or are establishing OR groups within their organizations, or have been served by one of the OR consulting groups. Several American Universities offer courses leading to advanced degrees in OR at the Master's or Doctor's Level, including M.I.T. and Columbia where such programs were started in 1951.

Three new professional societies have been founded since World War II, each with its own regular publications and meetings, to develop and disseminate knowledge in some area of science and engineering relevant to management and operations problems of the kind dealt with by OR. One book already published[2] provides an excellent introduction to industrial OR, including a "selected bibliography" of over 300 items; many other books, monographs, conference proceedings, and handbooks on OR have either been published or are now well along in the publication process.

Special OR training programs have been or are being established. Some are company operated, as in the General Electric Company, and are designed to "retread" present top personnel so that they can assume key OR positions with the company. Some are "short courses" of a few weeks duration, as at MIT and various other institutions, and are designed to acquaint potential practitioners and consumers of OR with the elements of the field. Some are centered around a "new" man who is either brought into the company as an OR expert from the outside, or who is an "old-timer" sent away temporarily for suitable re-education in OR. Opinions vary widely[2] as to the best way for a company to organize its initial OR effort; certainly no one way is equally well suited to all organizations.

Many techniques are identified by at least one competent OR author as within the field. They are not mutually exclusive, they are not all of equal importance, and they are not all accepted as appropriate for an OR list by everyone, but they do serve well to show the kind of tools that are found in OR kits. First, a simple listing.

Search theory
Systems analysis
Game theory

Linear programming theory
Queueing theory
Inventory control theory
Statistical decision theory
Information theory
Experimental design
Sampling theory
Stochastic processes
Monte Carlo method
Operational gaming
Time series prediction theory
Servo-mechanism theory
Transportation theory
Assignment theory
Scheduling theory
Boolean Algebra
Renewal theory
Simulation
Probability theory
Statistical inference

A few special terms pertinent to OR science will be defined to help us classify our tangled list of 20-odd topics. Thus, "model" is the accepted OR term for formal hypothesis. And, "parameter" refers to each of the several quantities identified within the model as controllable or measurable, and also of particular interest in the study of the operation or system.

For example, a "mathematical model" of a chemical process might connect some output characteristic, such as purity, with some process parameter, such as temperature, by means of an algebraic relationship for which the range of allowable values of output quantity and process parameter are specified.

As is often the case, the process under study will simply be too complex to permit of manageable algebraic description and the OR man must resort to "simulation." This simulation may range from a complex pilot plant, or a set of runs on a digital computer,[4] to a simple analysis using relevant nomograms.

All of these simulations are nonalgebraic models with the undesirable feature that the powerful analytical and manipulative techniques of modern mathematics cannot be used, and such simulations also are often difficult to check over an adequate range of values for parameters and variables.

At any rate, the main outline of scientific method, as used also in OR, is evident, as:

- *Model*—a formal representation of relationship between output quantities, process and system parameters, and environmental variables; mathematical, if possible, otherwise simulation.
- *Test*—a systematic program of experiment and observation leading to working acceptance of model if convincing sample of trial conditions is found to obey the model.
- *Scope*—the present ranges of values of environmental variables, process parameters, and output variables for which the validity of the model is believed established on the basis of test evidence and logical analysis.

Some mathematical models, like Boolean algebra and probability theory, have been defined very precisely in axiomatic form and are accompanied by an imposing structure of proved theorems that follow inexorably from the axioms. Some, like queueing theory and servo-mechanism theory, refer only to a fairly well defined body of mathematical theorems.

Others, like linear programming theory and game theory, started off with quite precise and limited mathematical formulations and then later acquired much broader significance as more and more tangential results were published.

The important features common to all mathematical models are the preciseness, conciseness and permanence with which results can be stated, once found. Hence, a successful application of one of them to a practical problem carries along with it automatically the logical implications derived from all subsequent mathematical findings based on its form. Here is the main source of the power of the scientific method, as in OR, whether the formal model takes the algebraic form typical of pure mathematics or that of the precise jargon of modern chemistry, nuclear physics, or genetics.

In our present terms, among the important special techniques for planning, conducting, or analyzing tests of models are: experimental design, Monte Carlo method, and statistical inference. Experimental design and statistical inference are familiar terms in modern science and engineering; they refer to skills and formulas that enable a present-day statistician to test models efficiently, in terms of efforts expended to achieve desired degrees of confidence in the conclusions. Monte Carlo method[5] is a term that stands loosely for the techniques of introducing controlled randomness repetitively into a numerical analysis, or a test, so that observed behavior is properly averaged over the population of possible environmental conditions of concern to the analyst.

The term systems analysis[6] commonly refers to any OR study in which all factors of interest have been incorporated explicitly into some kind of formal model, either mathematically or by simulation. Operational gaming[7] is a fairly new term, following after the time-honored war-gaming concept in military circles, that refers to a repetitive play of a "*game*" by human actors. Such a game is designed to simulate the situation under study by imposing formal rules that govern the allowable information, resources, actions and decisions available to each actor at each stage of play in as realistic a manner as possible.

A complex systems analysis or operational game is quite often made practicable, as a useful simulation, by the availability of modern high-speed electronic computers—because of their great speed, and because of their capacity for storing the tremendous quantities of information that must be processed in the course of such studies.

The compelling reason for using operational gaming, rather than systems analysis exclusively, is that human factors often can not be treated ade-

Meet the Author

MERRILL M. FLOOD, since 1953 a Columbia University professor, has been engaged in research and consulting some 20 years. His special interests are in fields in which mathematical techniques and operating research methods can be applied. Much of his work has been in system engineering and operations-research approaches to design and operating problems in production automation. Besides his duties as professor of industrial and management engineering, Dr. Flood serves Columbia as director of its Institute of Research in the Management of Industrial Production and is a consultant on operations research to Carbide and Carbon Chemicals Company. Holder of bachelor's and master's degrees in mathematics from the University of Nebraska, he took his Ph. D. at Princeton University.

quately by means of a mathematical or physical model. And, in any event, the responsible manager must eventually enter the framework directly or indirectly since he must decide whether or not to accept the conclusions of the OR study as a basis for his actions.

It would be quite impossible in this brief article even to describe the principal features of many of the mathematical models. In lieu of this, sample uses of these models made or proposed for treating industrial OR problems are given in the accompanying box. Most of these models have been used in connection with a wide range of industrial OR problems. For example, a few among the many applications already found for linear programming theory are the following:

Resource allocation
Transportation scheduling
Warehouse planning
Production scheduling
Inventory control
Bid evaluation
Executive compensation
Portfolio selection
Gasoline blending
Personnel assignment
Job scheduling
Assembly line balancing
Livestock feeding
Decentralization
Subsidies
Plant layout

The techniques of OR may be applied to a number of industrial problems . . .

Application	*Technique*
Optimum distribution of sales effort[8]	Search theory
Timing and pricing in a competitive market[9]	Game theory
Refinery problems[10]	Linear programming theory
Provision of spare equipment[11]	Queueing theory
Economic lot size and inventory control[12]	Inventory control theory
Inventory control[13]	Statistical decision theory
Data processing system design[14]	Information theory
Simplified accounting and auditing[15]	Sampling theory
Sequential process improvement[16]	Stochastic processes
Sales forecasting[17]	Time series prediction
Production control[18]	Servo-mechanism theory
Scheduling a tanker fleet[19]	Transportation theory
Equipment and personnel assignment[20]	Assignment theory
Assembly line and production scheduling[21, 22]	Scheduling theory
Checking contract consistency[23]	Boolean algebra
Service life estimation[24]	Renewal theory
Effect of promotional effort on sales[25]	Probability theory

It is not surprising, since uncertainty and its measurement is a central problem facing managers, that probability theory finds a use in nearly every OR study that is at all realistic. As a matter of fact, probabilities enter explicitly in 10 of the 17 mathematical models listed in the accompanying box. No wonder then that some authors write that OR is mostly statistics and probability.

The time is ripe for extensive use of the powerful experimental methods of science in the solution of management and operating problems in industry. New and dependable knowledge concerning the basic common characteristics of industrial operations, as it is acquired in the course of systematic experimentation and careful observation of this kind, will provide the information necessary for the development of a succession of models of ever increasing scope and validity.

Each new insight stored in such a model is soon reflected in a multitude of improvements in industrial management. This is the history and the goal of industrial operations research.

LITERTURE CITED

[1] Solow, Herbert. "Operations Research: Newest Tool of Decision Makers," *Fortune*, Vol. 53 (February, 1956).

[2] McCloskey and Trefethen (Eds.). *Operations Research for Management*, Johns Hopkins Press (1954).

[3] Hermann and Magee. "Operations Research for Management," *Harvard Business Review*, Vol. 31 (July-August, 1953), pp. 100-112.

[4] Hurd, Cuthbert C. "Computing in Management Science," *Management Science*, Vol. 1 (January, 1955), pp. 103-114.

[5] King, Gilbert W. "The Monte Carlo Method as a Natural Mode of Expression in Operations Research," *Journal of the Operations Research Society of America*, Vol. 1 (February, 1953), pp. 46-51.

[6] Hitch, Charles. "An Appreciation of Systems Analysis," *Journal of the Operations Research Society of America*, Vol. 3 (November, 1955), pp. 466-481.

[7] Cushen, W. E. "Operational Gaming in Industry," Seminar Paper No. 18 (March, 1955), Johns Hopkins University, Informal Seminar in Operations Research.

[8] Morse, Philip M. "Progress in Operations Research." In: *Operations Research for Management*, McCloskey and Trefethen (Eds.) Johns Hopkins Press (1954), pp. 99-116.

[9] Shubik, Martin. "The Uses of Game Theory in Management Science," *Management Science*, Vol. 2 (October, 1955).

[10] Symonds, Gifford H. *Linear Programming: The Solution of Refinery Problems*. Esso Standard Oil Company, New York (1955).

[11] Taylor and Jackson. "Application of Birth and Death Process to Provision of Spare Machines," *Operational Research Quarterly*, Vol. 5 (December, 1954), pp. 95-108.

[12] Whitin, T. M. "Inventory Control Research: A Survey," *Management Science*, Vol. 1 (October, 1954), pp. 32-40.

[13] Dvoretzky, Kiefer and Wolfowitz. "The Inventory Problem," *Econometrica*, Vol. 20 (April, 1952), pp. 187-222 and (July, 1952), pp. 450-466.

[14] Macy, Josiah, Jr. "Semantic Noise in an Information Processing Group," *Management Science*, Vol. 1 (January, 1955), p. 189 (abstract).

[15] Abhahat, Newton A. "Some Statistical Shortcuts in Auditing," Seminar Paper No. 11 (January, 1954), Johns Hopkins University Informal Seminar in Operations Research.

[16] Anderson, R. L. "Recent Advances in Finding Best Operating Conditions," *Journal of the American Statistical Association*, Vol. 48 (December, 1953), pp. 789-798.

[17] Roos, Charles F. "Survey of Economic Forecasting Techniques," *Econometrica*, Vol. 23 (October, 1955), pp. 363-395.

[18] Holt and Simon. "Optimal Decision Rules for Production and Inventory Control." In: *Proceedings of the Conference on Operations Research in Production and Inventory Control*, Case Institute of Technology (January, 1954), pp. 73-89.

[19] Flood, Merrill M. "Application of Transportation Theory to Scheduling a Military Tanker Fleet," *Journal of the Operations Research Society of America*, Vol. 2 (May, 1954), pp. 150-162.

[20] Flood, Merrill M. "The Traveling-Salesman Problem," *Journal of the Operations Research Society of America*, Vol. 4 (1956).

[21] Salveson, M. E. "The Assembly Line Balancing Problem," *Journal of Industrial Engineering*, Vol. 6 (May-June, 1954), pp. 18-26.

[22] Vazsonyi, Andrew. "The Use of Mathematics in Production and Inventory Control," *Management Science*, Vol. 1 (October, 1954), pp. 70-85, and (April-July, 1955), pp. 207-223.

[23] Berkeley, Edmund C. "Boolean Algebra (the Technique for Manipulating 'and,' 'or,' 'not,' and Conditions) and Applications to Insurance," *The Record of the American Institute of Actuaries*, Vol. 26 (October, 1937), pp. 373-414.

[24] Goodman, Leo A. "Methods of Measuring Useful Life of Equipment Under Operational Conditions," *Journal of the American Statistical Association*, Vol. 48 (September, 1953), pp. 503-530.

[25] Magee, John F. "The Effect of Promotional Effort on Sales," *Journal of the Operations Research Society of America*, Vol. 1 (February, 1953), pp. 64-74.

POSTWAR PERIODICALS

Management Science. The Institute of Management Sciences, Attn. Dr. George Kozmetsky, 336 No. Foothill Road, Beverly Hills, California.

Journal of the Operations Research Society of America. Attn. N. E. Miller III, Mount Royal and Guilford Avenues, Baltimore 2, Maryland.

Operational Research Quarterly. Operational Research Society (London), Attn. Dr. Peter B. Myers, Bell Telephone Laboratories, Murray Hill, New Jersey.

New Management Tool

OR shows how the different problems tie in

Refining Can Use Operations Research

- **Want to achieve optimum operations?**
- **What factors influence the operations?**
- **Which factors are the most important?**

Arthur A. Brown
Arthur D. Little Inc., Cambridge, Mass.

A NUMBER of petroleum refining companies have found it profitable during the past few years to broaden their research activities into the field of operations research. To cite two examples, Standard Oil Company of Ohio has set up an operations research component in its manufacturing department, and Humble Oil & Refining Company has published a report of two operations research studies.

The name "operations research" is a label which covers a wide variety of particular points for investigation and a number of investigatory methods. Almost all—if not all—of the problems are familiar to the refinery executive and to the planning engineer. Some of the methods, however, are probably new in the industry.

The operations research concept has in many cases added a new dimension to the formulation of problems by recognizing the interconnection between different problems and broadening the framework into which the solution must be fitted. To the extent that this is so, the problems can legitimately be called new, even when the elements are well known.

In the industrial field, operations research covers the flow of materials through an industrial process—procurement, processing, and distribution. The flow is governed by physical facilities and factors (properties of the materials, plant equipment, etc.). The operating practices are governed by economic factors. Operations research is aimed at the construction and development of a quantitative theory of the relationship of the important factors in a new operation.

The ultimate goal is, of course, to provide management with proper quantitative information, and a useful quantitative language as a basis for decisions about operations which include numerous variable and uncertain factors.

Refining Can Use Operations Research . . .

In a research-based attack on a particular operating problem, the emphasis is on understanding how the operation responds to a variety of stimuli. In an inventory control problem, for example, an operations research team would start by turning the operating question of "How big should inventories be?" into questions of cause and effects, such as: "How can manufacturing costs and efficiency be affected by the size and mix of inventories?"; "How can production schedules be affected by inventories?"; "How can the company's ability to service customer orders vary with the inventory size and composition?"

In each of these questions the word "how" is interpreted to mean "by what mechanism." Thus, the approach is to find the underlying causes which generate the need for inventories, and to identify the forces which tend to restrict their size. More important is the problem of determining quantitatively how these forces interact.

The process begins with observation of the operation, the gathering of facts, impressions and opinions. From these, previous experience in business or science will suggest tentative assumptions or hypotheses as to the basic laws which may govern the operation under study.

Scientific background and experience often may suggest analogous situations and assumptions which have proved to be of practical use. For example, the clue to a sales problem was found by an operations research team in a concept used by physicists to describe the mass behavior of atoms. The recognition of such useful similarities in apparently different situations is the creative step in operations research, as it is in any scientific undertaking.

Two separate areas of study typically are considered in an operations research program which is sponsored by, and carried out in the interests of refinery executives.

- The first is concerned with the inter-relationships among operating units of the refinery and with refinery practices as they affect internal economies.
- The second is concerned with relationship of the refinery to other components of the company.

The material problems in both areas are of the same general nature; namely, how to get the best use out of existing facilities, and how to determine what new facilities may be required in order to expand operations or to operate more economically at present levels.

The criterion, the frame of reference if you will, is usually the profitability of the company as a whole. Often it is the use of this frame of reference which constitutes the most distinctive contribution of the operations research approach to problems in any one sector of the company's total activities.

Problems which lend themselves to the operations research approach are those which are of interest to the executive and which cannot be suitably solved at a subordinate level. Among such are studies aimed at providing a better theoretical basis for planning activities, treating the refinery as a complex unit, and studies aimed at clarifying the relationships among the individual units.

Experience in many fields of operations has shown that a substantial cross-connection exists among the external and internal problems. In the long run, no single problem is successfully solved in isolation from the remainder. In the short run, however, progress necessarily must be made along a few lines of research, with solutions taken as temporary but useful approximations to those which may emerge from later and wider studies.

An extensive analysis of the interconnections is beyond the scope of the present discussion. Here it seems more useful to suggest a number of questions which have been or can be attacked by the methods and in the spirit of operations research, merely indicating the type of inter-connections which may be found.

Finished product tankage is one such question. The amount of storage needed for each of the various products depends on a set of factors —both external and internal—with complex interrelationships. Allowance must be made for seasonal storage, the amount depending on the lifting program and the storage available at distribution centers. Further allowance must be made for working stocks to meet tankship and customer cargo sizes, and for reserve stocks to meet foreseeable fluctuations in short-run demand.

The minimum tankage requirements for each of the several finished products therefore depend on such external factors as the market and the distribution system. In addition it is necessary to take into account the restraints on product mix which arise from the refinery structure and practices. Storage requirements for gasoline stocks depend, for example, not only on the gasoline market, but also on the throughput of fuel oils and middle distillates.

In one recent study in this field the primary objective was to determine the optimum levels of finished heating oil tankage for various levels of heating oil demand. Secondary objectives were to optimize decision rules with respect to heating oil production and to using seasonal tankage as working tankage during the portion of the year that it was available as such.

In this case a Monte Carlo program for the 650 computer was developed to determine the optimum heating oil finished tankage. The system simulated on the computer comprised the seasonal storage and pumping facilities, the finished heating oil tankage, the heating oil production and seasonal-to-finished tankage pumping rules, the tanker dispatching rules which provide long-term predictability but short-term variability, the tanker heating oil lot size distributions, and the use of Monte Carlo methods for introducing randomness in tanker arrivals and heating oil lot sizes.

The model developed in this project constitutes a tool with which management can handle all of the finished tankage determinations except those involving factors not included in this study.

Crude supply and refining is another area of the petroleum industry in which operations research can be effective. The relationship between crude storage, refinery scheduling and emergency variations in acceptance rate, must be determined so as to minimize the total cost of inventories and excess tankage on the one hand, and expenses due to disruption of planned operations on the other hand.

Questions such as these concern the specification of facilities as determined by the relationship between the refinery and the operations which precede and follow it. Other questions concern the refinery as a unit in itself. There will be the question of the optimum use of refinery facilities to meet a given set of requirements, those which may be generated by the market or those set by crude supply.

The theory of linear programming has been applied with some success to the solution of the question of optimum use of refinery facilities. Typically the linear programming procedure results in a specification of finished product quantities and of throughput and recycle rates. But although substantial progress has been made through use of the elementary theory, much work remains to be done in several directions.

Linear programming is a special instance of a more general procedure for specifying optimum operating conditions subject to constraints and cost and profit conditions. A good deal of theoretical work has yet to be done in order to take account of discontinuities and to provide optimum programs when demands, inputs and yield rates are subject to uncertainty.

Optimum company operations will require a large amount of research into many particular situations. For one organization of company operations it may be profitable to allow the refinery to operate at maximum efficiency, while for another specified organization, over-all company profit may be increased by penalizing refinery operations in favor of distribution, market or production efficiency.

The decisions as to where the inefficiency should be incurred must be made in the light of over-all system studies. An operations research group at the refinery level can contribute significantly to the solution of such system-wide problems by developing a usable working model of the refinery as an operating unit.

Internal analysis of refinery operations breaks the refinery up into a complex of smaller units and studies the relationships among them. The familiar general questions occur:

- What is the relationship between facilities and practices?
- What internal tankage is needed to decouple successive operations?
- How far is it desirable to provide flexibility?
- What are the quantitative relationships between facilities costs and lead times?
- If a particular unit—say a coker—is run at maximum efficiency, what penalties are incurred in operating other units?
- Do these penalties lower the total profit?

Allied to these questions are others concerned with the balance of operating forces. For example, one may ask what the balance should be between scheduled maintenance and emergency repairs, or what the maintenance expenditure should be to achieve a specified level of reliability, or—in some cases—how to specify reliability levels quantitatively.

The scope and variety of the problems in refinery operations which lend themselves to the operations research approach suggest the extent to which this new field of applied science can contribute to the industry as a whole. Operations research has been used successfully to improve planning of distribution systems and to evaluate the effectiveness of advertising programs.

It can contribute to improving the bases for decisions on such questions as the sales potential of proposed new service stations, and even the optimum number of pumps and attendants for any location. It can help determine the optimum density of oil wells in a particular field.

As operations throughout the petroleum industry increasingly are subject to this type of analysis and control, improved understanding will develop of the inter-relationships among the various functions. The operations research approach can contribute new ways of interpreting data and ways of measuring factors not measured before, as well as new and better ways of measuring effectiveness. It makes possible more trustworthy predictions of the results that can be expected from alternative decisions.

In turn, operations research itself will be developed into an increasingly effective tool as experience refines its usefulness.

On May 29, 1953, John B. Lathrop made the following statements before the American Society for Quality Control: "The natural growth of research within a company leads to its emergence from the laboratory to deal first with problems of how new products or processes affect sales and costs, then to manufacturing processes and productivity. It is then applied to scheduling of production and inventories, to physical distribution, and later to the evaluation of sales, advertising and promotional efforts."

And he added: "When scientific research personnel using the theoretical and quantitative methods of the basic research, have participated in creating the bases for decisions in all of these management areas for any company, there exists operations research in its most effective form, regardless of what it may be called."

Operations research is a new field of applied science but it is, at the same time a continuation of traditional practices. In the oil industry operations research constitutes an extension of well-established research programs. ##

Meet the Author

ARTHUR A. BROWN is a member of the Operations Research staff of Arthur D. Little, Inc. This staff, made up of mathematicians and physical scientists, together with members experienced in business administration, applies the scientific method to problems in marketing, production and control. Before joining the group in 1952, Dr. Brown spent 10 years in operations research with the Navy. For more than three years, he was assigned to the headquarters of the Commander-in-Chief of the Pacific Fleet, and from 1944 to 1952, he was deputy director of an Operations Evaluation group in the Office of the Chief of Naval Operations. A Rhodes Scholar, Dr. Brown received his Ph.D. in mathematics at Princeton University in 1940.

New Management Tool

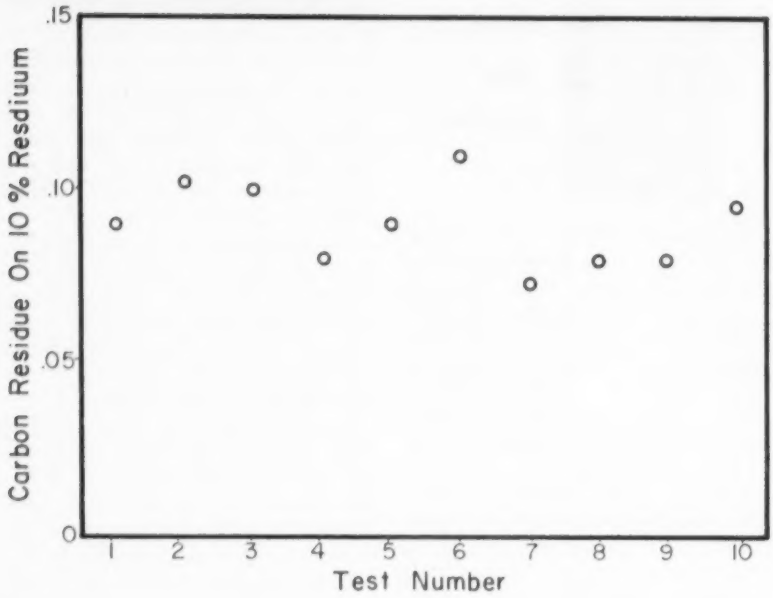


FIGURE 1—Variations occur even on repeated analysis of the same sample.

How Reliable Are Lab Analyses?

Better control of an operation requires better information concerning the products of that operation.

John T. Walter
University of Pittsburgh, Pittsburgh, Pa.

SUPPOSE YOU had to measure a room in your home with an elastic yardstick. The measuring stick is one that changes in length each time it is laid on the floor. How good do you think the final measurement would be?

A chemical analysis is something like this elastic yardstick, changing from day to day, from hour to hour. To decrease its elasticity is to increase the reliability of the laboratory test.

The refinery laboratory is a kind of product quality measuring stick. It is your guide in making daily operating decisions. However, the attempt to control quality through an unreliable laboratory is similar to driving a car with considerable play in the steering mechanism. In either case one cannot easily hold to the chosen course. Better control calls for taking up some of the slack in the steering device.

Analytical Variation — Inaccuracies in testing are referred to as analytical variations. If repeated tests are made on a standard sample, differences in results can be expected. Even the best of laboratories does not reproduce exactly the same findings for all trials. Variation is normal. The difference between poor laboratory work and good is not the difference between variability and no variability. It is a matter of degree of variation.

What happened when a test was performed a number of times on the same sample is shown in Figure 1. Here we see a pattern of variability graphically portrayed. The differences are due to analytical variation alone, not to product quality variation, since there is none of the latter in a standard sample.

The data represented in Figure 1 are reported in Table 1. In this table the analytical variation is calculated in the form of the standard deviation, which is found to be 0.012. Standard tables are published which predict the frequency distribution expected from a large number of trial measurements by knowing the standard deviation of a small number of determinations.[2] These are known as "t" tables. For the data given here, the "t" table indicates that 95 percent of the test results may be expected to fall between 0.063 and 0.12, and 99 percent between 0.051 and 0.13. Measurement of this variation is an important step toward improvement of product quality.

Process Variation—Total variation in a quality measurement includes both analytical and process variability. Distinguishing between the two removes some of the uncertainty from production control. Total variation and process variation may also be expressed as standard deviations for comparison with analytical variation. The computation for process variation is

$$\sigma_p = \sqrt{(\sigma_t^2 - \sigma_a^2)}$$

where
σ_t = Total variation
σ_a = Analytical variation
σ_p = Process variation

Residual process variation, determined in this manner, is only an

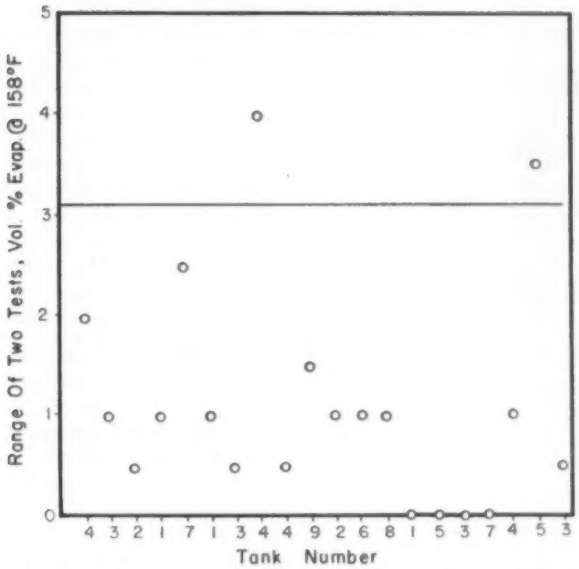


FIGURE 2—When ranges exceed the control limit, the reason usually can be determined.

approximation which gets better as the number of observations entering into each of the other two standard deviations becomes larger.

After careful investigation one refinery reported losses of almost one million dollars per year on a single operation due to quality give-away. Failure to achieve the desired quality was due to variability which is expressed as the total variation (σ_t) of the formula just stated. Further study disclosed that laboratory variability accounted for 75 percent of the total variation, measured as percent evaporated at 158 F. during a distillation test. It was 35 percent of the variation for percent evaporated at 212 F., 23 percent at 257 F., and 49 percent at 356 F. In the Reid vapor pressure test the laboratory variability was 31 percent of the total variation.

In addition to the losses involved in quality give-away, one should count the cost of storage and re-processing of products withheld from the market because of failure to meet quality standards. There are also deliveries of below standard products due to inaccurate chemical analysis. In all, better testing means increased operating efficiency and reduced costs.

Replicate Testing—Several approaches are possible in attacking the problem of analytical variability. One is to test all process samples two or more times, averaging the results. This replication of tests is said to reduce variability because errors tend to cancel each other, being both positive and negative. That is to say, variability may be reduced or precision of tests increased by replication.

Increased precision is not enough. Some errors fall consistently in one direction or the other. Repetition of such errors does not improve accuracy of test results. Either a positive or negative bias may be due to incorrect methods, carelessness of operators, or poor equipment. Whatever the cause, correction is desirable, although not forthcoming from this kind of program.

L. H. C. Tippett[4] comments as follows: ". . . the application of statistical theory to purely experimental error (as opposed to real or natural variations) is beset with doubts and difficulties, and it is far better to improve experimental technique so as to reduce such errors to unimportant limits."

It should be noted in passing that use of process control charts employing averages achieves an effect similar to that accomplished by test replication. It is done without the extra laboratory cost involved in multiple testing, while at the same time improving process control. However, process control charts are not the main concern in the present discussion. That subject has been dealt with elsewhere.[3]

Control Charts—Installation of laboratory control charts is an important step toward reduction of analytical variation at its source. These can be charts of ranges, using the range of two tests made on the same sample. Special samples are not required. Merely take routine samples currently being tested for process control purposes and subject them to two tests instead of one. Avoid having the same analyst perform both tests. Differences between such test results are due to the testing, not to the product. The ranges are an index of analytical variation and are plotted in chronological order on the control chart.

Figure 2 is a portion of a control chart actually used in a refinery laboratory for tests of finished gasoline. It illustrates the charting of ranges. The data represented in this chart are reported in Table 2.

Computation of Control Limits—A limit line for the control chart is determined from previous test results

TABLE 1
Carbon Residue on 10 Percent Residuum

Test No.	X	X^2
1	.090	.0081
2	.102	.0104
3	.100	.0100
4	.080	.0064
5	.090	.0081
6	.110	.0121
7	.072	.0052
8	.080	.0064
9	.080	.0064
10	.095	.0090
Σ	.899	.0821

Computing the Analytical Variation (σ_a):

$$\sigma_a = \sqrt{\frac{(\Sigma x^2) - (\bar{x})\ (\Sigma x)}{N - 1}}$$

$$= \sqrt{\frac{(0.0821) - (0.0899)\ (0.899)}{10 - 1}}$$

$$= 0.012$$

where
X = each test result
Σ = sum of
N = number of tests
$\bar{X}$ = arithmetic mean of X's
σ = standard deviation

TABLE 2
Volume Percent Evaporated at 158 F

Test No.	Tank No.	Original Test	Replicate Test	Range (R)
1	4	18.0	16.0	2.0
2	3	14.5	15.5	1.0
3	2	14.5	15.0	0.5
4	1	16.0	15.0	1.0
5	7	16.0	13.5	2.5
6	1	16.0	15.0	1.0
7	3	15.0	15.5	0.5
8	4	14.5	18.5	4.0
9	4	17.5	18.0	0.5
10	9	16.0	14.5	1.5
11	2	17.0	16.0	1.0
12	6	18.0	19.0	1.0
13	8	10.0	11.0	1.0
14	1	17.5	17.5	0.0
15	5	17.0	17.0	0.0
16	3	17.0	17.0	0.0
17	7	18.0	18.0	0.0
18	4	18.0	17.0	1.0
19	5	15.0	18.5	3.5
20	3	10.5	11.0	0.5

and is intended to separate the normal pattern of variability from extremes of variation. The data and method for computing a control line are reported in Table 3. These data were obtained before the period represented in Figure 2.

The first average range ($\bar{R}$) in the computations was 1.38. Multiplied by a factor designated $D_{3\sigma}$, taken from standard tables of multipliers,[1] which is 3.267, a tentative limit of 4.51 was computed. Since three standard deviations cover nearly one hundred percent of the variation in the sampling distribution, one of the ranges, being 5.5, was excluded as unrepresentative of that distribution. After this exclusion a new $\bar{R}$ of 1.25 was found, based upon one less range, and a new 3σ limit of 4.08 resulted. Since no single range now exceeds 4.08, this $\bar{R}$ is acceptable.

To establish a control limit with a 5 percent risk level, the $D_{0.05}$ factor of 2.455 is multiplied by the acceptable $\bar{R}$ of 1.25 to obtain the limit of 3.07. Ranges within this limit on the control chart are viewed as arising from non-assignable causes. They are satisfactory in the sense that immediate improvement is not in prospect. Ranges above the control limit are rare and are said to be due to assignable causes. These are causes which can be determined and eliminated. A 5 percent risk level means that there is a 5 percent risk of being wrong in deciding that assignable causes are present.

One effect of charting is to center attention upon the largest errors first. By concentrating on these errors it is reasonable to expect maximum improvement in laboratory procedure with the minimum of effort. The control chart serves as a kind of score board, showing how much progress has been made in keeping errors down to the lowest possible level.

A point above the control limit is like the sounding of an alarm. It calls for an investigation, however brief. It pays to strike while the iron is hot. Evidence is more easily found if no time is lost in looking for it. Close attention to the control chart means that notice is given immediately when something goes wrong.

Of course, there is an economic side to the use of control charts. Busy laboratory personnel must produce results, often under pressure. How much time can they afford to spend looking for causes of out of control points? Maybe very little the first time. However, if several ranges fall outside the limit line, it may be more economical to beat the bushes until an explanation is found.

Also, when single points are very far out, they should be taken seriously. The same is true for occasional out of control points increasingly farther out each time. Control charts tell their own stories in various ways that are meaningful to management.

A new control limit is determined periodically. It should be lower each time it is computed, if control charts have only recently been installed. Lower limits are an indication of improvement in anlytical technique. They also set a new and more difficult goal of staying within the limit. Some of what were formerly non-assignable causes now become assignable causes.

In Control—At some time it will be found that the control limit cannot be reduced farther. When this happens over an extended period and the pattern of variation is fairly even, the test is said to be in statistical control. Analytical variation has then been reduced to the bare minimum for the existing state of knowledge. While it never disappears entirely, analytical variation may be cut as much as 50 percent by bringing the testing procedure into statistical control.

After that the problem is one of maintaining progress already made. Future improvement is not to be ruled out, however. But, it will come only with some new idea not now being applied. Achieving statistical control in the first place is more a matter of systematically using known methods. It means better training and greater alertness. The control chart is a means toward those ends.

Once a laboratory operation is in control, duplicate tests are no longer required on all routine samples. It now becomes a matter of spot checking. The frequency will depend on circumstances. Once a day may be enough, plotting the ranges on the control chart in order of occurrence.

When there is trouble, duplicate tests can be run more often until it is cleared up. With the tapering off of duplicate testing the cost of maintaining a control chart is reduced considerably, the first cost having been only temporary. Gains are realized in better process control through a laboratory that is functioning more efficiently.

Meet the Author

JOHN T. WALTER was educated at Drexel Institute of Technology, Columbia University, New York University and the University of Pittsburgh. A management consultant, Dr. Walter has been on the faculty of the University of Pittsburgh's School of Business Administration since 1947. He is an associate professor of statistics. His background in laboratory control by statistical methods is the result of recent experience in the petroleum industry.

TABLE 3—Computation of Control Limits

Range of Two Tests		
	2.5	3.5
	2.0	2.0
2.0	2.5	5.5
1.0	0.0	6.0
0.0	0.5	0.0
0.5	3.0	1.5
1.0	0.0	3.0
0.5	2.5	1.0
1.0	0.0	0.5
0.0	2.5	0.5
2.5	1.0	2.0
0.5	0.5	
		Σ 45.5

First Computation:
$\bar{R} = 45.5/33 = 1.38$
$D_{3\sigma} = 3.267$ From "Table of Multipliers"
3σ Limit $= (3.267)\ (1.38) = 4.51$
Therefore, exclude range of 5.5

Second Computation:
$\bar{R} = 40.0/32 = 1.25$
3σ Limit $= (3.267)\ (1.25) = 4.08$
Therefore, all ranges now within limit.

Computing Control Limit at 5 Percent Risk:
$D_{0.05} = 2.455$ From "Table of Multipliers"
Control Limit $= (2.455)\ (1.25) = 3.07$

Definition of Symbols:
$\bar{R}$ = average range
D_3 = multiplier for 3 control limit for ranges
$D_{0.05}$ = multiplier for 5 percent risk level control limit for ranges

LITERATURE CITED

[1] Heide, John D., *Industrial Process Control by Statistical Methods* (New York: McGraw-Hill Book Company, Inc., 1952), pp. 74-77, and 84-87.
[2] Lewis, Edward E., *Methods of Statistical Analysis in Economics and Business* (Boston: Houghton Mifflin Co., 1953), pp. 140-42, 199-200, and 214.
[3] Walter, John T., "Statistical Quality Control," Petroleum Refiner (February, 1954), 149-152.
[4] *Technological Applications of Statistics* (New York: John Wiley & Sons, Inc., 1950), p. 104.

New Management Tool

Will you supply any of the required . . .

Petrochemicals in Synthetic Fibers

Acetylene
Acrylonitrile
p-Xylene

Thomas C. Ponder and J. J. McKetta

Petroleum Refiner Staff

TODAY THE petrochemical industry is growing at a very rapid rate and one of the principal reasons for its phenomenal growth is simply that the population is increasing and demanding more of the things that are made from petrochemicals.

Let us take a look at one of the most used items of our economy—fibers. Very good data are available on both synthetic and natural fiber consumption in the U. S. An interesting and important point is that synthetic fiber production greatly exceeds synthetic film production.

This article covers the consumption of petrochemicals in the synthetic fiber industry.

In 1954 the total U. S. consumption of fibers was in excess of 6 billion pounds. This amounted to about 40 pounds per person. Over the past decade there has been a population increase of 1.4 percent and the growth rate in the consumption of fibers during this time has been about 140 million pounds per year. With an assumed future growth rate in the consumption of all fibers of a con-

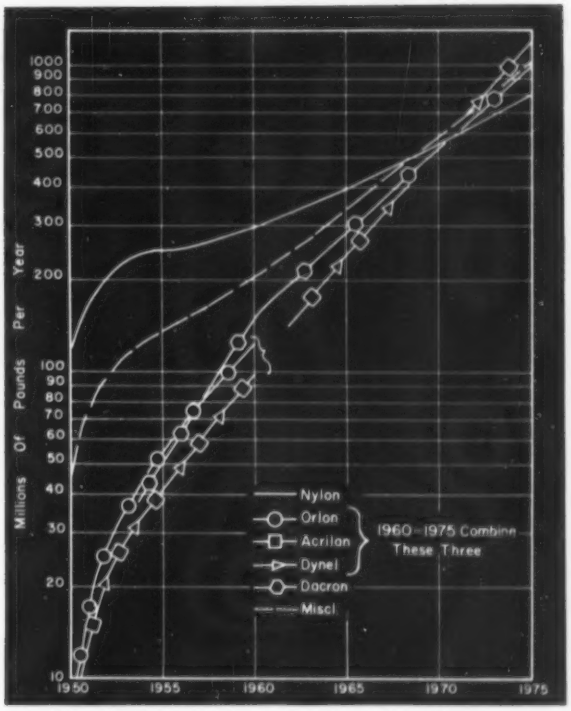


FIGURE 1—Synthetic fiber production.

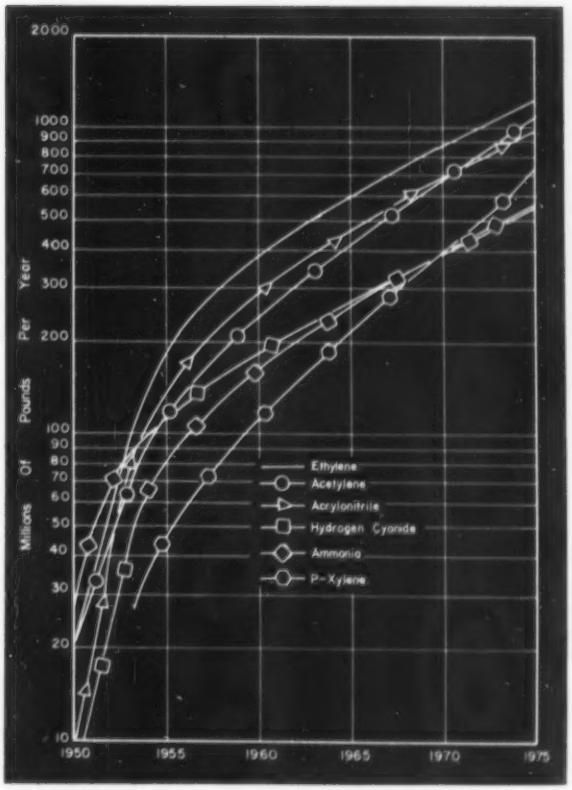


FIGURE 2—Petrochemical requirements for synthetic fibers.

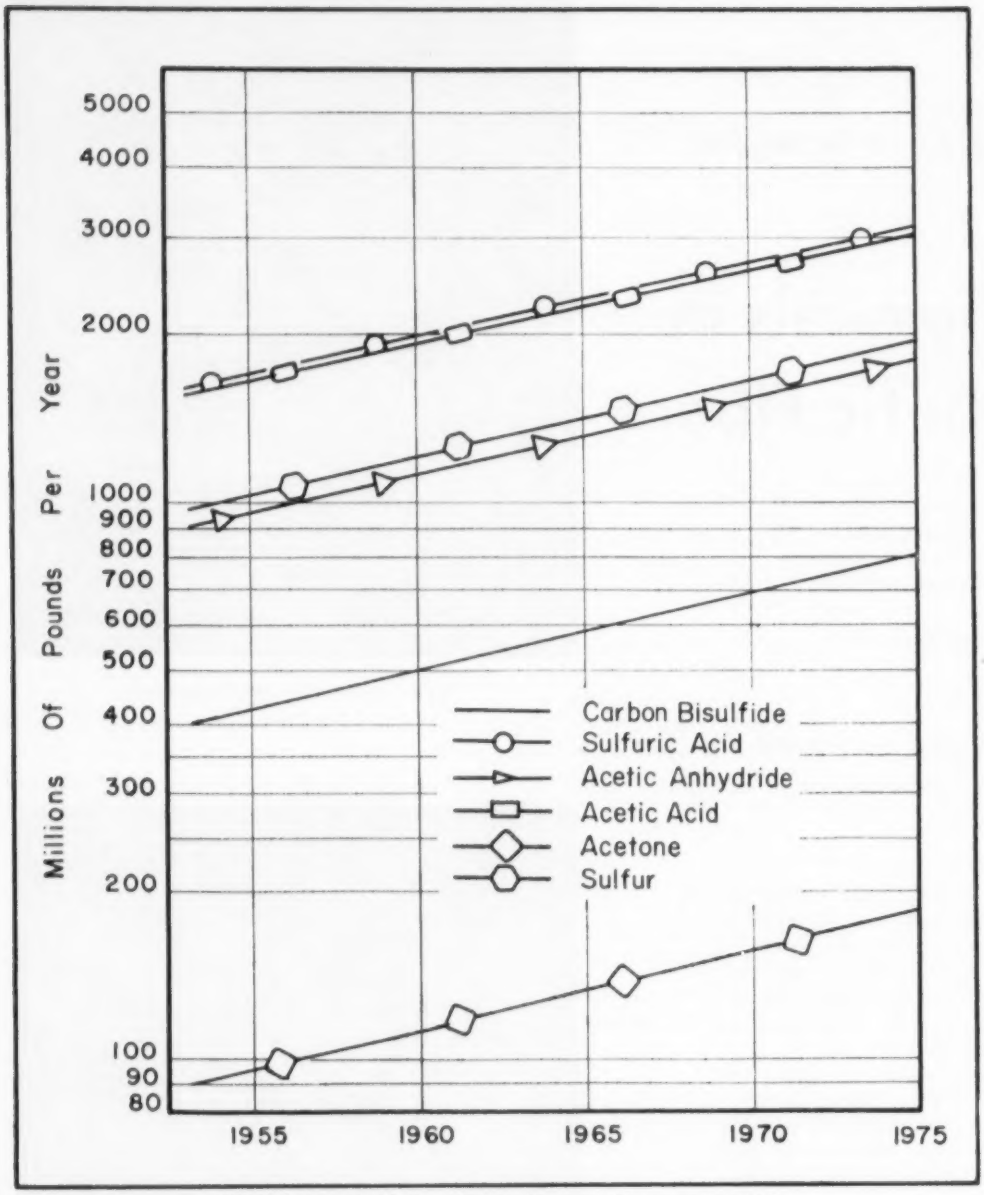


FIGURE 3—Petrochemical requirements for rayon (viscose and acetate).

servative 90 million pounds per year the fiber consumption by 1965 should increase to approximately 7.6 billion pounds per year and by 1975 to about 8.7 billion pounds.

The fibers of most interest to the petrochemical industry are the man-made non-cellulosic synthetic fibers. The distribution of fibers in the U. S. in 1954 was as follows:

	1954 percent		Man-made distribution
Cotton	69	Cellulosic	19%
Wool	6	Non-cellulosic	6%
Silk	0.1		
Man-made	25		

The origin of the various non-cellulosic fibers, aromatic and non-aromatic, is classified as follows:

Not of Aromatic origin
- Orlon (acrylic fiber)
- Acrilan (acrylic fiber)
- Dynel (vinyl fiber)
- Saran
- Vicara (protein fiber)
- Glass

Of Aromatic origin
- Nylon 66
- Nylon 6
- Long chain polyamides
- Dacron (polyester fiber)

It has been estimated that by 1975 the total consumption of man-made fibers will exceed 7 billion pounds per year. This is a terrific increase over the 1.5 billion pounds consumed during 1955. Figure 1 shows the production trend of these fibers in the future.

By 1960 Nylon production will increase 3 times over the 1950 figure; Orlon almost 20 times over the 1950 production; Dynel 20 times over 1950; Acrilan in excess of three times over 1953; and Dacron about 5 times over 1953. These increased consumptions of the non-cellulosic fibers will

demand an increasing amount of petrochemical raw materials. These petrochemicals are shown in Figure 2.

In studying Figure 2 one must remember that the amounts of ethylene and acetylene are not additive and could be juggled somewhat but the total of the two petrochemicals is approximately correct. Also keep in mind that the requirements shown for acrylonitrile and hydrogen cyanide are not in addition to the ethylene, acetylene, and ammonia but are included under these materials. They are plotted to indicate some of the intermediate petrochemicals which will be required for the synthetic fiber industry. From Figure 2 can be seen that the increase of ethylene-acetylene consumption from 1950 to 1975 is about 50 fold. Acrylonitrile consumption increase over 1950 will be about 100 fold; the amount of ammonia going into synthetic fibers over 1950 will increase over 20 fold by 1975; and p-xylene consumption by 1975 will have increased over 1953 by more than 30 fold.

One cannot neglect the cellulosic man-made fibers, although they require far less petrochemicals for their raw materials. It is estimated that rayon production will rise to about 3 billion pounds annually by 1975. If a 70 percent production of viscose and a 30 percent production of acetate is assumed, the chemical consumption will be as shown in Figure 3. Sulfuric acid, sulfur and methane have been included in the Figure 3 even though they are usually not considered petrochemicals. From Figure 3 it will be noted that carbon bisulfide consumption over 1953 will almost double by 1975; sulfuric acid consumption in rayon will double over 1953 by 1975; acetic anhydride and acetic acid should double by 1975; acetone and sulfur used in rayon manufacture will also double by 1975.

TABLE 1—Value of Petrochemical Requirements for Synthetic Fibers

	Millions of Dollars per Year*			
	1950	1953	1960	1975
Ethylene	1.3	6.1	17.1	75.2
Acetylene	1.2	4.2	14.8	66.2
Acrylonitrile	2.9	26.6	89.2	310
Hydrogen Cyanide	5	46.5	154.8	537.7
Ammonia	1.2	4	8.2	26
Benzene	8.8	21.1	26.4	70.5
p-Xylene	....	4.5	19.3	128.5
Carbon Bisulfide	....	2.1	2.6	4.1
Sulfuric Acid	....	17.9	22.4	34.5
Acetic Anhydride	....	127.6	159.6	252
Acetic Acid	....	159.6	199.5	315
Acetone	....	6.3	7.9	12.6
Sulfur	....	13.5	17	26.7

* 1955 Prices

The impact of the increased consumption of petrochemicals in the synthetic fiber industry can best be illustrated by the expected plant expansions and investment increases for facilities for the manufacture of these petrochemicals. Figure 4 illustrates the expected increase in total petrochemical production for synthetic fibers and also shows the annual investment in new plants and expansions for the production of these petrochemicals. Note from Figure 4 that total petrochemical production is expected to increase from 1560 million pounds in 1955 to 2540 million pounds by 1975. The total investment in plants to produce these petrochemicals for synthetic fibers will be $243.1 million between 1955 and 1975.

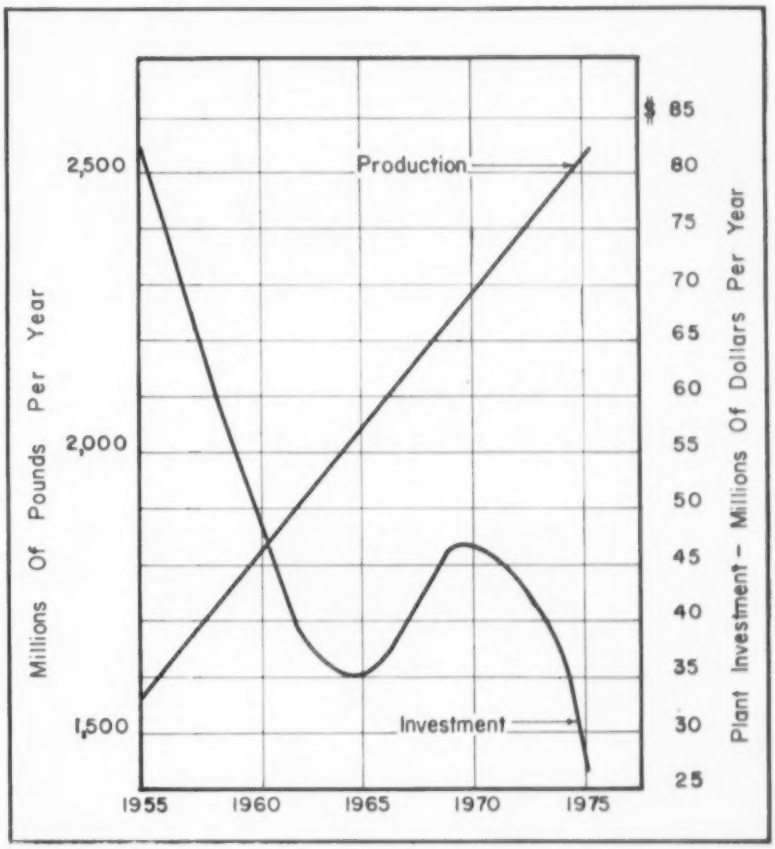


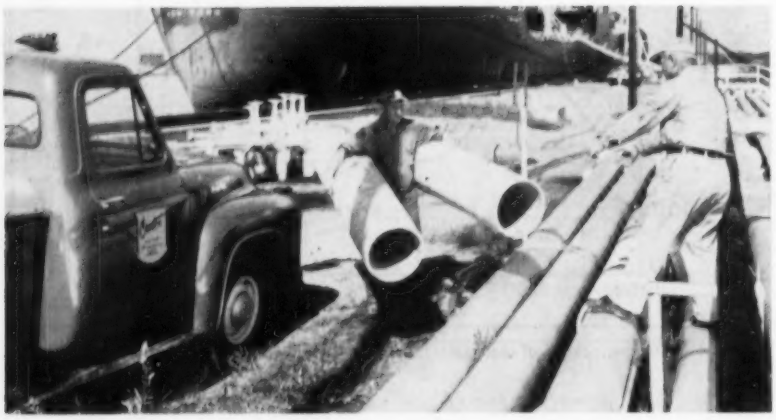
FIGURE 4—Total petrochemical requirements for synthetic fibers and plant investments required.

On the basis of 1955 prices for these petrochemicals Table 1 gives the dollar value of these raw materials and the expected increase in dollar value in the next 20 years. Examination of Table 1 will show that the value of ethylene-acetylene production consumed in synthetic fibers will increase about 14 times between 1953 and 1975; acrylonitrile for synthetic fibers will increase about 12 times over 1953 to a value in excess of $310 million. The value of ammonia consumed in synthetic fibers by 1975 will be $26 million; benzene consumption valued at $70.5 million is expected by 1975. Pare-xylene valued in excess of $128.5 million will be consumed by synthetic fibers in 1975. The total value of petrochemicals consumed by the rayon industry in 1975 will be in excess of $614 million.

Only the consumption of petrochemicals by the synthetic fiber industry has been considered here. It should be noted that to meet this demand the petrochemical industry will invest a total of $243 million in the next 20 years for new plants and increased production facilities. These data are based on conservative expectations of the increased demands for synthetic fibers. Synthetic fibers represent only one portion of the use of petrochemicals. ##

Featuring one-piece construction, this flexible shape-retaining insulation cuts labor costs to almost one-third. The men just spead the tube open, drop it onto the pipe and snap—it's closed. A two-man crew can apply the insulation and "cinch" it into place with wire binders.

Snap-On Insulation



Extremely light six-foot sections mean easy, rapid installation. Glass fiber construction reduces insulation replacement, particularly when in service in areas of extreme dampness or where the corrosive properties of salt water are in evidence.

A minimum life of 20 years is expected for this installation. When repairs or tie-ins are required on the line, the one-piece sections can be removed without breakage or adhering to the pipe. This means that the same piece of insulation may be reapplied.

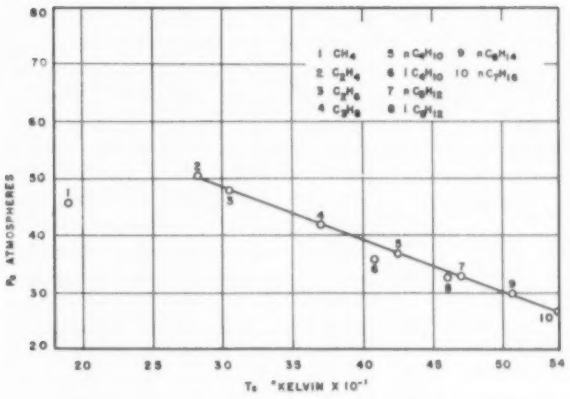


FIGURE 1—Critical pressure and temperature for some light hydrocarbons.

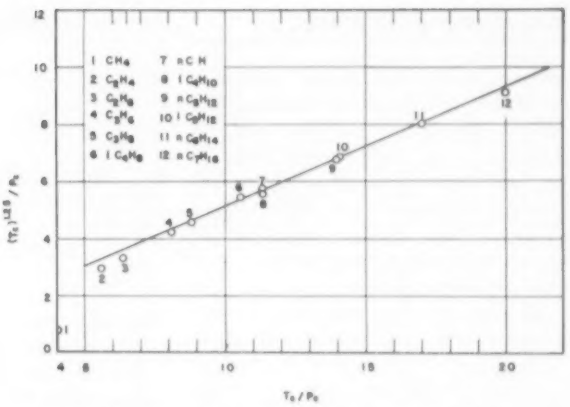


FIGURE 2—Test of the Redlich-Kwong equation of state.

For complex mixtures . . .

There's a Limit to Use of Equations of State

In view of the extensive use of the mixture rules of equations of state, and the use of correlating factors such as the molal average boiling point, it is necessary that you be careful of the limitations.

Lawrence N. Canjar
Carnegie Institute of Technology
Pittsburgh

It is not suggested here that the use of mixture rules be abandoned. On the contrary they are invalid at times only because of their simplicity. To propose a more correct set of rules would involve increased complexity to the point where they would no longer be of practical use to design engineers. However in purely scientific work, such as analyzing experimental vapor-liquid equilibrium data, they should be used only with great caution.

IN RECENT YEARS considerable attention has been focused on the problem of estimating thermodynamic properties of complex mixtures. As early as 1936, Kay[9] attempted to apply the generalized compressibility factor chart to hydrocarbon mixtures and later, Su, Huang and Chang[14] extended his work to mixtures containing non-hydrocarbons. These investigators were successful in predicting mixture compressibilities by use of pseudo-critical properties which were in effect mixture rules to be used with the generalized compressibility factor plot. Later Gamson & Watson[7] and Joffe[8] applied the Kay pseudo-critical concept to the problem of predicting fugacities in gas mixtures. Other investigators have suggested changes in the original mixture rules proposed by Kay. The most recent change is that of Redlich and Kwong[11] who also developed a generalized equation of state to be used with their mixture rules.

Extensive work has also been carried out on the application of mixture rules to empirical equations of state of pure components for the purpose of predicting mixture behavior. An excellent review of this work has been presented by Beattie and Stockmayer.[1] However, the most ambitious and widely used work is that of Benedict, Webb, Rubin and Friend.[3] These investigators first developed an equation of state which not only described the behavior of a superheated gas, but also predicted pressure-volume-temperature properties in the two phase region. They then developed mixture rules whereby the constants in the equations of state for pure compounds could be combined and used as constants in equations of state for mixtures. In the final phases of this work they computed fugacities for hydrocarbons in both liquid and gas mixtures and correlated them with a factor called the molal average boiling point (MABP) which is, in effect, a mixture rule in itself.

The work of Benedict and his coworkers opened the way for a host of other papers based on the Benedict fugacities and equation of state. All of these papers made use of the mixture rules as well as the equation of state. Stotler and Benedict[13] correlated vapor-liquid equilibria data on nitrogen-methane and Schiller and Canjar[12] did the same for nitrogen-carbon monoxide using fugacities calculated from Benedict-Webb-Rubin equation of state. De Priester[5] has published vapor-liquid equilibrium distribution coefficients for hydrocarbons based on the original work of Benedict, et al.[3] Papadopoulos, Pigford and Friend[10] and Canjar and Edmister[4] have developed two com-

pilations of partial molal enthalpies of lighter hydrocarbons both having their origin in the original work of Benedict, et al.[5] Just recently Edmister and Ruby[6] presented generalized activity coefficients for hydrocarbon mixtures. The last five papers made use of the molal average boiling point as a correlating factor.

In view of this extensive use of mixture rules for equations of state

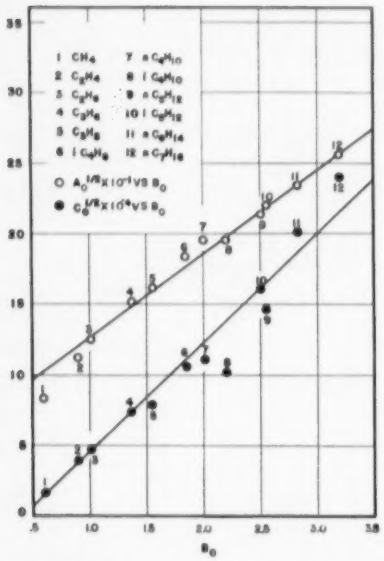


FIGURE 3—Relation of $A_o^{1/2}$ and $C_o^{1/2}$ to B_o.

and correlating factors such as the molal average boiling point it is quite appropriate that their limitations be pointed out. Herein lies the purpose of this article.

Kay's Pseudo-critical Concept—In order to understand the nature of different mixture rules more clearly, the simplest will be discussed first. These are the pseudo-critical temperature and pseudo-critical pressure which were first proposed by Kay[11] to be used in conjunction with the generalized compressibility factor plot. Since it had been found that compressibility factor Z was a function of reduced pressure, Pr, and reduced temperature, Tr, for pure components, Kay made an attempt to use these same functions to describe mixture behavior. The problem reduced itself to the proper selection of critical pressure and critical temperature for mixtures to be used in the definition of reduced temperature and reduced pressure given by:

$$Tr = \frac{T}{T_c} \quad (a)$$

$$Pr = \frac{P}{P_c} \quad (b) \qquad (1)$$

Kay had reasonable success with the use of pseudo-critical constants defined by

$$T_{c_{mix}} = \Sigma y_i T_{c_i} \quad (a)$$

$$P_{c_{mix}} = \Sigma y_i P_{c_i} \quad (b) \qquad (2)$$

However, equations (2) were tested primarily with binary mixtures.

To illustrate immediately the limitation of the Kay pseudo-critical constants as mixture rules it is necessary to refer to Figure 1 which is a plot of critical pressures versus critical temperatures of some of the light hydrocarbons. It will be noted that all the points, with the exception of methane, fall roughly about a straight line. This means that the critical pressure can be approximately given by the equation

$$P_{c_i} = \alpha + \beta T_{c_i} \qquad (3)$$

Multiply equation (3) by yi the mole fraction of component i in a given mixture and equation (4) is obtained.

$$y_i P_{c_i} = y_i \alpha + \beta y_i T_{c_i} \qquad (4)$$

An equation relating pseudo-critical pressure to pseudo-critical temperature can be obtained by summing over-all components.

$$\Sigma y_i P_{c_i} = \alpha \Sigma y_i + \beta \Sigma y_i T_{c_i} \qquad (5)$$

or $$P_{c_{mix}} = \alpha + \beta T_{c_{mix}}$$

It should be noted that the same equation relates the pseudo-critical pressures to pseudo-critical temperatures of mixtures and critical pressures to critical temperatures of pure components. Or, in other words, if the pseudo-critical temperature of a mixture should equal the critical temperature of a pure component then the pseudo-critical pressure of the mixture must of necessity equal the critical pressure of that same pure component. The conclusion is of no consequence in the case of binary mixtures but in ternary systems it is all important. In any ternary system there is always a component whose critical temperature and critical pressure each lie between the critical temperatures and critical pressures of the other two components. There exists therefore an infinite number of mixtures in which

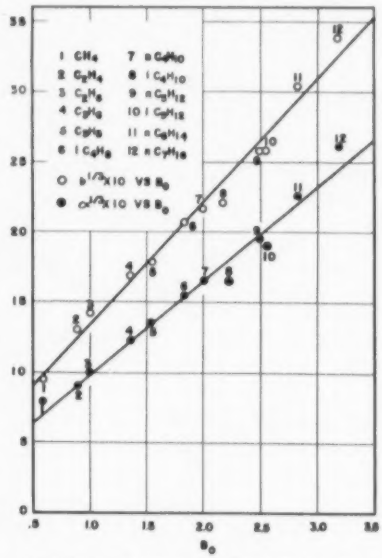


FIGURE 4—Relation of $b^{1/3}$ and $\alpha^{1/3}$ to B_o.

the pseudo-critical pressure and the pseudo-critical temperature of the mixture are equal to the critical temperature and critical pressure of the pure component. And therefore the pressure-volume-temperature relationships of these mixtures as predicted by the generalized compressibility factor and Kay's pseudo-critical constants will be identical with those of the pure component.

To understand the significance of this situation consider a ternary system composed of components *A*, *B*, and *C*. Let *A* and *C* have critical properties such that the pseudo-critical pressure and pseudo-critical temperature of a given binary mixture of *A* and *C* are equal to the critical pressure and critical temperature, respectively, of component *B*. Then if Kay's pseudo-critical constants are used with generalized compressibility factor, a

Meet the Author

LAWRENCE N. CANJAR completed both his graduate and undergraduate work at Carnegie Institute of Technology, and is now a member of the faculty. Presently an associate professor, he joined the chemical engineering staff in 1951. In addition to his teaching and research activities, Dr. Canjar has been engaged as a thermodynamics consultant for L'Air Liquide Society, a consulting senior research chemical engineer for API and as a partner in a Pittsburgh consulting firm, Associated Chemical Engineers.

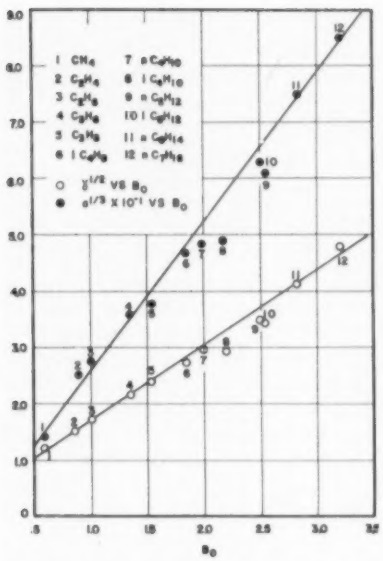


FIGURE 5—Relation of $\gamma^{1/2}$ and $a^{1/3}$ to B_o.

ternary mixture of *B* and the given binary *A-C* will be calculated to have the same specific volume for all concentrations of *B* and consequently exhibit no volume change on mixing. The partial molal volume of *B* will equal the specific volume of *B* at all concentrations of *B* from 0 to 100 percent as long as *B* is being mixed with the given binary *A-C*. In light of the fact that binary mixtures of *B-A* and *B-C* exhibit volume changes of mixing *it is highly improbable that the ternary described above will not also exhibit a volume change on mixing.*

In a quaternary system there exists an infinite number of ternary mixtures that have pseudo-critical properties which are equal to the critical properties of two of the components. In each of these situations Kay's pseudo-critical concept would predict that the partial volumes are equal to specific volumes for these components. *It is on the basis of this highly improbable conclusion that the mixture rules known as pseudo-critical temperature and pseudo-critical pressure can be said to be invalid.*

Redlich-Kwong Equation of State—This same principle can be used to demonstrate the invalidity of other mixture rules proposed for other equations of state. Redlich[11] in trying to improve on the work of Kay developed an equation of state of the form

$$P = \frac{RT}{v - b} - \frac{a}{T^{1/2}v(v + b)} \quad (6)$$

where $a = 0.4278R^2\frac{T_c^{2.5}}{P_c}$ (a)

$$b = 0.0867R\frac{T_c}{P_c} \quad (b) \quad (7)$$

The following rules have been suggested for mixtures.

$$a^{1/2}_{mix} = \Sigma y_i a_i^{1/2} \quad (a)$$

$$b_{mix} = \Sigma y_i b \quad (b) \quad (8)$$

If the quantity $a^{1/2}$ which is proportional to $T_c^{1.25}/P_c^{0.5}$ is a linear function of b which is proportional to $(T_c/P_c)^{0.5}$ then by the procedure used in equations (3), (4) and (5), there must exist an infinite number of mixtures in tenary or more complex systems whose pressure volume temperature relationships are identical to those of one of the pure components comprising a mixture. Figure 2 shows that $T_c^{1.25}/P_c^{0.5}$ is roughly a linear function of $(P_c/T_c)^{0.5}$. Therefore the Redlich equation of state and corresponding mixture rules also fail to describe the behavior of mixtures more complicated than a binary.

Benedict-Webb-Rubin Equation of State—When empirical equations of state are considered the situation is much the same except there are a larger number of constants to consider. The Benedict-Webb-Rubin equation of state[3] is probably the most complicated equation developed to date. It is presented here in the virial form.

$$P = RTd + \left(BoRT - Ao - \frac{C_o}{T^2}\right)d^2 + (bRT - a)d^3 + a\alpha d^6 + \frac{cd^3}{T^2}(1 + \gamma d^2)e^{-\gamma d^2} \quad (9)$$

The mixture rules suggested by Benedict, et al are:

$$\begin{aligned} A_o^{1/2}{}_{mix} &= \Sigma y_i A_{o_i}{}^{1/2} \\ B_{o_{mix}} &= \Sigma y_i B_{o_i} \\ C_o^{1/2}{}_{mix} &= \Sigma y_i C_{o_i}{}^{1/2} \\ a^{1/2}{}_{mix} &= \Sigma y_i a_i{}^{1/2} \\ b^{1/2}{}_{mix} &= \Sigma y_i b_i{}^{1/2} \\ c^{1/2}{}_{mix} &= \Sigma y_i c_i{}^{1/2} \\ \alpha^{1/2}{}_{mix} &= \Sigma y_i \alpha_i{}^{1/2} \\ \gamma^{1/2}{}_{mix} &= \Sigma y_i \gamma_i{}^{1/2}{}_{mix} \end{aligned} \quad (10)$$

It should be noted that the constants given here do not have a unique set of values for any given compound but that an infinite number of combinations exists. For the purpose of this demonstration only the original constants as calculated by Benedict, et al[3] will be considered.

Following the same argument as before if it can be shown that

$A_o^{1/2}{}_i$ is a linear function of B_{o_i}
$C_o^{1/2}{}_i$ is a linear function of B_{o_i}
$a^{1/2}{}_i$ is a linear function of B_{o_i}
$b^{1/2}{}_i$ is a linear function of B_{o_i}
$c^{1/2}{}_i$ is a linear function of B_{o_i}
$\alpha^{1/2}{}_i$ is a linear function of B_{o_i}
$\gamma^{1/2}{}_i$ is a linear function of B_{o_i}

then the Benedict-Webb-Rubin equation of state also fails to describe the pressure-volume-temperature relationships of mixtures more complicated than a binary. Figures 3, 4, 5, 6 show that these linear relationships do exist between the various constants. It may be argued that since the constants are not properties of the pure components as in the case of critical constants and can be varied at will, the straight line relationships can be changed. This does not invalidate the conclusions drawn here, however. If the altered constants predict the same pressure-volume-temperature relationships of mixtures as those plotted in Figures 3, 4, 5 and 6, then it is not important that they do not follow linear relationships with each other since it has already been demonstrated that the predicted mixture behavior is incorrect. If the altered constants give different results for mixture behavior then there is something more fundamentally incorrect about the mixture rules. As a matter of fact, the flexibility of the constants strengthens the argument presented against the validity of mixture rules. Benedict points out that all of the constants may be simultaneously adjusted by as much as 5 percent and still retain the fit of the equation to experimental data. If this is true the points in Figures 3, 4, 5 and 6 can undoubtedly be adjusted to follow

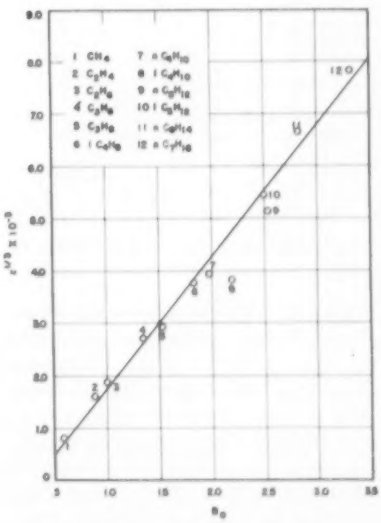


FIGURE 6—Relation of $c^{1/3}$ to B_o.

linear relationship better than they do now.

MABP Concept—It is interesting to also examine the concept of molal average boiling point. It is defined by equation (11).

$$MABP = \Sigma y_i B_i \qquad (11)$$

If each of the constants discussed above are plotted against normal boiling point for light hydrocarbons a linear relationship would be observed in each case. This is also true of the critical temperature and critical pressure. Figure 7 is a typical plot using the Benedict-Webb-Rubin equation constant $a^{1/3}$ as an example. Because of these linear relationships it can be concluded that mixtures of ternary and more complicated systems, whose MABP is equal to the normal boiling point of any component in the mixture, will have the same pressure-volume-temperature relationships as that of the pure component. For the same reason as before, it follows that the molal average boiling point fails as a correlating factor for multicomponent mixtures.

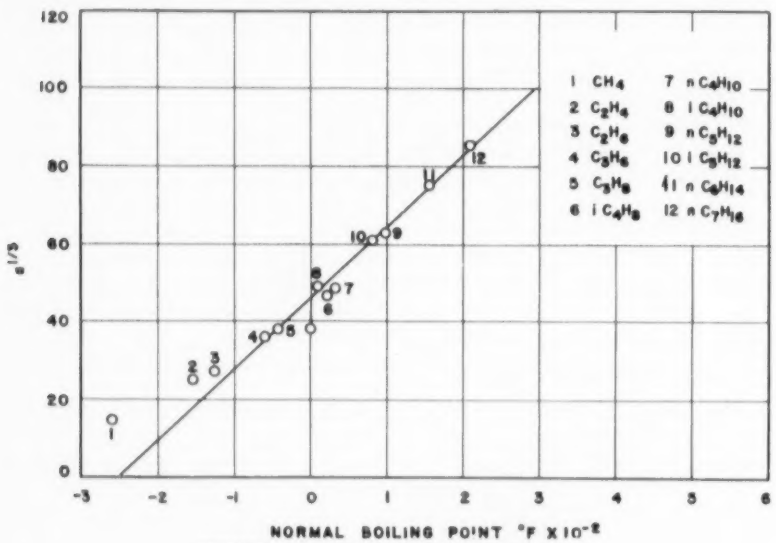


FIGURE 7—Effect of normal boiling point on $a^{1/3}$.

Other Thermodynamic Functions—Having established the inadequacy of mixture rules to predict volumetric behavior of multicomponent mixtures it is interesting to see how derived thermodynamic properties such as enthalpy and activity coefficients are thus affected. For those mixtures in which the partial molal volumes are equal to specific volumes for a given component it can be easily shown that the activity coefficient is equal to one and the partial molal enthalpy is equal to pure component enthalpy.

$$RT \ln \gamma_i = RT \ln \frac{\bar{f}_i}{y_i f_i} = \int_0^P (\bar{V}_i - v_i)\, dP \qquad (12)$$

$$\bar{H}_i - h_i = -RT^2 \frac{\partial \ln \gamma_i}{\partial T}_{P, comp} \qquad (13)$$

Equations (12) and (13) can be found in most standard texts on thermodynamics. Activity coefficient, γ, is defined here as the ratio of the fugacity of a component in a mixture to the fugacity of the pure component at the temperature and pressure of the mixture times the mol fraction of the component in the mixture. Equation 12 indicates that when the partial molal volume is equal to the specific volume at all pressures, the activity coefficient must be equal to unity. If this is also the case for all temperatures then the partial molal enthalpy must be equal to the specific enthalpy of the pure component by equation (13).

If the mixture rules which are being discussed here were valid, then a trace component could behave ideally in a ternary mixture. The only requirement for such behavior would be that the components distribute themselves in such a way that the MABP of the mixture is equal to the normal boiling point of the trace component. That this is not reasonable has been recognized by Benedict and Rubin themselves.[2] According to their equations for determining activity coefficients in ternary mixtures it is obvious that the activity coefficient of a component is equal to unity at concentrations other than 100 percent only in rare and special cases.

The correct use of the Benedict, Webb, Rubin and Friend[3] or De Priester[5] fugacity correlation involves the calculation of activity coefficients for pairs of binaries and averaging these according to the distribution of the components in the mixture. This procedure would not take into account ternary and higher interactions but would be more correct than the use of the simple MABP mixture rule. Of course this procedure loses a great advantage that the use of MABP concept gives to the design engineers. In using MABP to characterize a mixture it is not necessary to know the concentrations of each individual component. The modified use of these correlations suggested here requires that these concentrations be known beforehand and therefore leads to complicated trial and error procedures.

Nomenclature

B—normal boiling point
d—density
f—fugacity of pure component
$\bar{f}$—fugacity of component in mixture
h—specific enthalpy
$\bar{H}$—partial molal enthalpy
i—subscript referring in i th component
MABP—molal average boiling point ($\Sigma y_i B_i$)
P—pressure
P_c—critical pressure
P_r—reduced pressure (P/P_c)
R—gas constant
T—temperature
T_c—critical temperature
T_r—reduced temperature (T/T_c)
v—specific volume
$\bar{V}$—partial molal volume
y—mole fraction
γ—activity coefficient $\left(\frac{\bar{f}_i}{y f_i}\right)$

LITERATURE CITED

[1] Beattie, J. A. and Stockmayer, W. H., "Treatise on Physical Chemistry" Vol. II edited by Taylor and Glasstone. D. Van Nostrand (1951).
[2] Benedict, M., Johnson, C. A., Solomon, E. and Rubin, L. C., Trans. Am. Inst. of Chem. Engr., 41, 371 (1945).
[3] Benedict, M., Webb, G. B., Rubin, L. C. and Friend, L., C. E. P., 47, pp. 419, 449, 571 (1951).
[4] Canjar, L. N. and Edmister, W. C., C. E. P. Symposia, Series No. 7, 49, 73 (1953).
[5] De Priester, C. L., C. E. P. Symposia, Series No. 7, 49, 1 (1953).
[6] Edmister, W. C. and Ruby, C. L., C. E. P., 51, 95 (1955).
[7] Gamson, B. W. and Watson, K. M., "High Pressure Vapor Liquid Equilibria," National Petroleum News, Technical Section, 36, R-623 (1944).
[8] Joffe, J., "Fugacities of Gas Mixtures," I. E. C., 40, 1738 (1948).
[9] Kay, W. B., I. E. C., 28, 1014 (1936).
[10] Papadopoulos, A., Pigford, R. L. and Friend, L., C. E. P. Symposia, Series No. 7, 49, 119 (1953).
[11] Redlich, O. and Kwang, J. N. S., Chem. Rev., 44, 233 (1949).
[12] Schiller, F. C. and Canjar, L. N., C. E. P. Symposia, Series No. 7, 49, 67 (1953).
[13] Stotler, H. H. and Benedict, M., C. E. P. Symposia, Series No. 6, 49, 25 (1953).
[14] Su, G. J., Huang, P. H. and Chang, Y. M., JACS, 68, 1403 (1946).

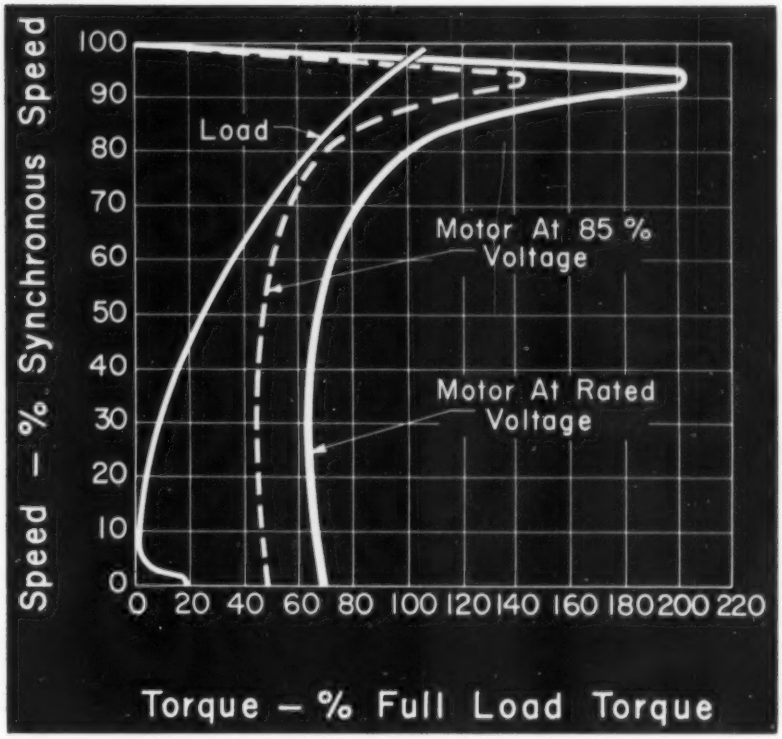


FIGURE 1—Comparative speed-torque characteristics for a typical centrifugal machine load and an induction rotor at rated voltage and 85 per cent voltage.

Know Your Motor Starting Problems

Here is help on some of the problems in a system where most of the load is in a few large machines.

Lee B. Eddy
Universal Oil Products Company
Des Plaines, Ill.

REFINERIES IN this country have installed new process units which require large amounts of power for driving pumps and compressors. Frequently the bulk of this power is used in a single or a few very large machines. A fluid catalytic cracking unit, for example, normally employs a main air blower rated in thousands of horsepower as contrasted to the remaining loads in the unit which may total a mere few hundred horsepower. Catalytic reforming units, which are being installed widely these days, include gas compressors of goliath ratings compared to the rest of the mechanical load. Where electric power rates and service continuity are favorable, a-c motors are frequently used to drive these large machines.

A large unbalance in the size of motors installed in one plant necessitates special precautions on the part of the designing electrical engineer. Because a single machine may represent a very large percentage of the total capacity of a refinery electrical system, starting of that motor may readily produce excessive and troublesome voltage drop in the supply and plant systems. This paper is devoted to a discussion of the problems which arise from the resulting unfavorable voltage conditions. Some solutions which have been employed to correct or minimize their effect upon refinery operation are given.

Acceleration of the Driven Machine—A look must always be taken at the starting torque requirements of the mechanical load to which a large motor is connected. It is fundamental that the motor must, at all speeds, be capable of delivering torque in excess of that required by the driven machine.[1,2] A graphical comparison of their speed-torque curves, exemplified in Figure 1, will indicate whether a given motor under specified conditions will fully accelerate its driven load to normal operating speed.

The greater the excess of motor torque over that required by the driven machine, the more rapid will be the acceleration. Actual accelerating time can be calculated for any specific set of conditions by using the method described in Appendix I. Typical torque requirements of refinery-type pumps and compressors are outlined in Appendix II.

In ordinary applications the starting torque available from a driving motor is of ample magnitude for successful acceleration when the machine is energized at rated voltage. In many refinery installations, however, the starting current drawn by a proportionally large motor will create voltage drop in the supplying electrical system, of such magnitude that the motor terminal voltage is materially lower than the name plate rating.

Low voltage critically reduces the torque of an induction motor, the torque varying in proportion to a value greater than the second power of the per-unit terminal voltage.[2] If, during starting, terminal voltage should drop to 85 percent of the rated value, the motor torque may be limited to as low as 70 percent of the torque available under full voltage conditions.

When the minimum terminal voltage and its effect on motor torque have been determined for a specific case, the comparative speed-torque curves of the driven and driving ma-

chines must be re-examined. The dash-line curve in Figure 1 illustrates the serious effect 85 percent of rated voltage produces on motor torque. The machine of Figure 1 will accelerate successfully, but will require over two and one half times as long to reach full speed because of the reduced net accelerating torque available. Prudence requires the designer to leave a reasonable margin of safety between the curves representing the torque characteristics of the motor and driven machine, for insurance against unusual conditions or inexact assumptions.

Limitations of the Electrical Supply System—Most refineries, and particularly the smaller ones, purchase their electric energy from local power companies. These utilities frequently limit the kva which may be drawn from their system, or the length of time a heavy load may remain on the system, or both. When faced with these restrictions, the designer of the refinery electrical system must weigh the relative necessities, advantages, and disadvantages of the following methods for meeting the supply system limitations: a low starting kva motor, various forms of reduced-voltage starting, and additional unloading of the driven machine.

These methods, however, must always be considered in view of the starting torque requirements of the pump or compressor. The use of large, wound-rotor motors, which is one combined solution to the above problems, is usually avoided in refineries because of their expense, complication, and potential explosion hazard. Also, the efficiency of a wound-rotor machine is usually slightly less than that of a comparable squirrel-cage motor.

In most refinery applications, a large motor is started very infrequently, and a power company will often recognize this operational condition by relaxing their standard regulations against high values or duration of starting current.

Reduced-voltage starting is the most obvious method of lowering the starting kva drawn by a motor. The necessary equipment is expensive, however, and the lowered voltage at the motor terminals results in markedly decreased torque capabilities and longer accelerating times. Where limited starting kva is essential and accelerating torque is a critical factor, transformer-type reduced voltage starting is preferred to reactor-type starting since the resulting torque, for a given decrease in line starting current, is considerably greater.

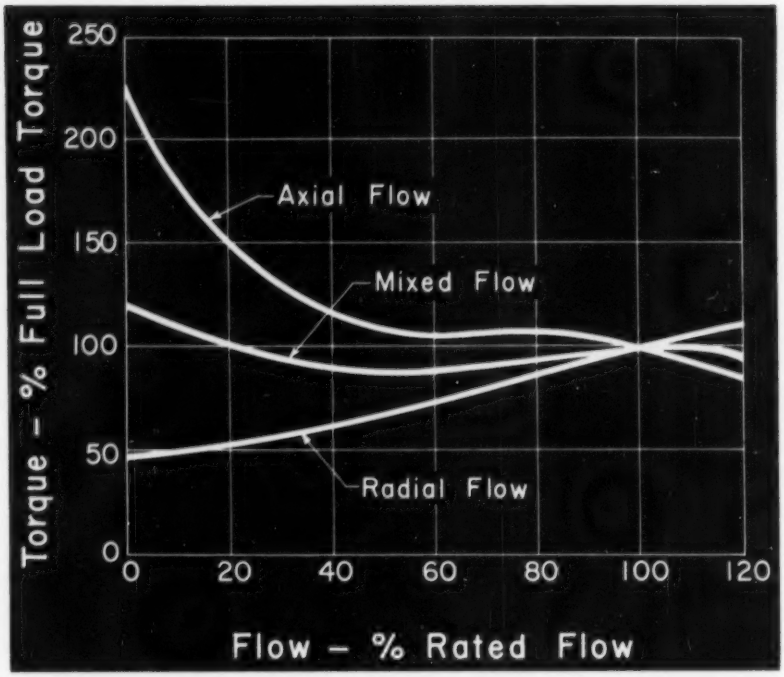


FIGURE 2—Torque-flow characteristics for typical refinery pumps operating at rated speed.

In an area where power company limitations are stringent, and in a situation where comparatively high starting torque is required by the driven machine, the combination of reduced-voltage starting equipment and a high-torque motor may be necessary. In general, however, large high-torque motors are not preferred for refinery service because this type of machine has a lower efficiency than that of comparably rated normal-torque motors. In a machine used for round-the-clock service, a small variation in efficiency can represent a substantial difference in the yearly power bill. For example, a change in efficiency of one percent in a 3000 horsepower motor may alter the yearly power cost by as much as 1600 dollars.

Low Voltage Effects on Plant Electrical Equipment—Heating in the Accelerating Motor and Control—Large motors which drive centrifugal machines may require an exceptionally long accelerating time. A high speed compressor geared to a motor, for instance, can have such a high value of effective inertia that full speed will not be achieved for one minute or more following energization. Because long accelerating times may cause thermal distress in an a-c motor, these applications should always be checked with the equipment manufacturer.

The total heat energy released in a motor, during starting, is increased by low terminal voltage and the resulting extension of accelerating time.[3] In extreme cases, a high-starting-torque motor to shorten the accelerating time, or a machine with extraordinary thermal capacity, may be required.

Transformers, reactors, or resistors employed in reduced voltage starting equipment must be thermally designed for extended accelerating times in those installations where starting voltage is low and the inertia of the rotating mass is high.

Effect on a Magnetic Starter Used to Control the Accelerating Motor—Where a magnetic starter is used to control a motor whose starting current materially reduces the plant voltage, the starter may incur excessive contact deterioration. This type of

damage is caused by the starter coil being supplied with insufficient voltage to hold the main contacts closed while starting current is flowing through them. As a result the starter opens and recloses several times during the accelerating period, thereby burning the starter contacts and producing violent voltage fluctuations in the plant electrical system.

In such installations, where the starting voltage may drop to 85 percent of normal or less, a d-c operating coil supplied with current from a rectifier will usually hold the main contacts closed.[4] Another solution to this problem is the use of an a-c operating coil rated at the starting voltage and a resistor which is connected in series with the coil when the plant voltage has returned to normal.

Effect on Other Magnetic Starters—If a large motor is started when connected to an exceptionally high-impedance system, or if control circuits or power feeders are very long, several or all of the smaller motors in a plant may stop because low voltage on their starter coils has caused the main contacts to open. The solution of this problem requires the use of apparatus to reduce the starting kva, as previously outlined, or a decrease in the impedance of power and control circuits. A long control circuit, whose impedance is largely reactive, may be benefited by replacing the starter coil with one of a lower voltage rating, or by using a low-burden interposing relay.

Effect on Other Motors—When the voltage changes at the terminals of an operating motor, the current varies in inverse proportion in order to maintain a constant power output. This high current which results from low terminal voltage, if persisting for very long, or repeatedly, can produce injurious heating in a motor. Also, this higher current flow aggravates the general voltage condition, during the starting of a large motor, by causing greater drop in the power conductors. In extreme cases, terminal voltage at an operating motor may be so low that breakdown torque is exceeded and the machine will stall. Standard methods of reducing the severity and duration of starting kva, and of reducing voltage drop in the plant system, will alleviate these conditions.

Meet the Author

LEE B. EDDY is an electrical engineer with Universal Oil Products Company, responsible for the design, inspection and startup of electrical systems for UOP lisencees. His duties also involve making operating and service recommendations for electrical systems. With Universal for the past three years, Eddy formerly was with Westinghouse Corporation, applying electrical equipment to pipe-line pumping stations. He is an electrical-engineering graduate from Oregon State College.

Momentary Power Failures—Continuity of the power supply is of paramount importance to a highly electrified refinery.[4,5] For this reason great emphasis is placed on the use of reclosing circuit breakers on the supply line and upon the installation of alternate feeders equipped with automatic switching equipment. With the aid of such apparatus, most power failures can be limited to a duration of a few seconds or less. Consideration should always be given to the effect of even a momentary outage on the motor-driven equipment so that process disturbances will be minimized.

Machine Unloading—Loss of voltage for a few seconds will usually slow a loaded machine to a speed from which reacceleration involves most of the same problems as when starting from standstill. Deceleration during a momentary failure is even greater if the electrical outage is produced by a line fault into which the plant motors, acting as generators, feed current.[6,7] In order for a motor to successfully reaccelerate following a momentary failure of either type, it is often necessary to automatically control the loading of the driven machine in the following ways:

Reciprocating compressors in an open fluid system, such as a gas concentration unit, are normally unloaded by lifting the suction valves until the machine has regained full speed.

Reciprocating compressors in a closed fluid system, such as a catalytic reforming unit, frequently lack automatic unloading equipment. Since continued flow of some recycle gas is very desirable for process reasons, at least one machine of several in parallel should be re-energized immediately following a momentary power failure. Because the compressed gas flows in a closed loop, the drop of pressure differential across one reciprocating compressor will soon decrease the torque requirement to a value which can be successfully accelerated by the motor driver. The other machines may then be unloaded manually and restarted by operators.

An electric motor-driven main air blower in a fluid catalytic cracking unit is normally equipped with either a suction throttling valve or inlet guide vanes for varying air flow. When a blower slows in speed during a momentary power failure, the process instrument will call for maximum air flow, unless artificially controlled in some manner, and will thus subject the motor to accelerating the blower under full load when voltage is restored.

To avoid this condition it may be necessary to temporarily lock the flow control in a position that will partially unload the blower and permit successful reacceleration. In order to prevent a sudden disturbance to the process unit when the control is returned to normal operation, this return should be placed under the discretion of the operator so that the transition may be effected gradually.

Simultaneous Restarting of Many Motors—Equipping many of the motors in a refinery with undervoltage time-delay controls, which permit automatic restarting following a momentary outage, is common practice nowadays. Such practice, however, makes the low-voltage conditions discussed thus far, in regard to one machine, even more severe and complex. When half the motors in a plant are drawing starting current at the same time, voltage conditions can be an engineer's nightmare. Motors which fail to accelerate fully, and contactors which repeatedly open and close, may combine to throw an electrical system into chaos.

Any multiple application of time delay controls should be given a care-

ful engineering analysis which includes consideration of the maximum duration of an outage, system impedance, the rate of deceleration for the several machines, and the self-genererated voltage characteristics of the plant motors when de-energized. Normally only a minimum of the most essential drives should be equipped with time-delay devices. If continued operation of many motors is imperative for process stability, sequential restarting of motors can be arranged through the use of special controls.

Surge Currents Upon Reenergization—If the power supply to a refinery is deenergized and immediately reenergized before the residual voltage generated by the plant machines has decayed to a comparatively low value, the plant motors may be subjected to excessive surge currents. If the residual plant voltage is high and at an unfavorable phase angle with respect to the supply system voltage at the instant of reconnection, the plant motors may experience a first-cycle surge of 10 to 15 times full load current.[8]

A current flow of this magnitude can theoretically overstress the mechanical bracing of the windings, exceed the sheer limits of a motor shaft, and damage couplings and connected gear units. Mechanical torque effects are particularly hazardous when a motor is connected to a high inertia load such as a high speed centrifugal compressor. Surge currents and their effects are aggravated if large banks of capacitors are connected in parallel with the motors, since they tend to maintain the generated voltage at a high level and, under some conditions, at a level greater than the motor rating.

Existing literature is remarkably lacking in records of machine damage attributable to surge currents. However, a cautious system designer should not ignore their theoretical effects merely because experience to date has not substantiated the calculated possibilities. Many authors feel that reenergization should be delayed until residual voltage has decayed to 25 percent of normal.[7, 9, 10] In a typical refinery containing one or several large motors, the necessary delay is in the order of one second or longer. Unfortunately a purposely introduced time delay permits machines to decelerate to a lower speed and accentuates the problems associated with automatic restarting.

Conclusion—Modern innovations in the petroleum refining process industry have created cogent problems for the electrical engineer. The use of proportionally large a-c motors compells the system designer to make a careful study of the many factors involved in the starting and control of these machines. This paper was presented at the AIEE Petroleum Technical Conference, Sept. 12, 1955, Houston.

LITERATURE CITED

[1] Application of Large Alternating Current Motors and Controls in Refineries and Pipelines, G. L. Oscarson, *AIEE Transactions*, 1954 Vol. 73, Part II, p. 296-301.

[2] Relation Between Speed-Torque of Motors at Various Starting Inrush Current Values, and Speed-Torque Relation for Pumps with Closed and Open Head Gate Valves (Conference Paper), Benton Bejack, AIEE Petroleum Industry Conference, Tulsa, Oklahoma, September 28, 1954.

[3] Selection and Application of Large Motors in Oil Refineries (Conference Paper), C. M. Lathrop, E. J. Winsor, AIEE Winter General Meeting, New York, N. Y., January 18-22, 1955.

[4] The Electric System Reliability Required in Petroleum Refining (Conference Paper), E. R. Felton, AIEE Fall General Meeting, New Orleans, La., October 13-17, 1952.

[5] Reliable Electric Power Essential to Processing, T. L. Cappel, Jr., *The Petroleum Engineer*, November, 1953, pp. c-10-12.

[6] Time Variation of Industrial System Short-Circuit Currents and Induction Motor Contributions, W. C. Huening, Jr., AIEE Winter General Meeting, New York, N. Y., January 31-February 4, 1955.

[7] Relay Response to Motor Residual Voltage During Automatic Transfers, A. R. Kelly, Paper No. 55-427. Presented at AIEE Summer General Meeting, Swampscott, Mass., June 27-July 1, 1955.

[8] Application of Capacitors for Power Factor Improvement of Induction Motors, W. C. Bloomquist, W. K. Boice, *AIEE Transactions*, May, 1945, Vol. 64, p. 274-278.

[9] Bus Transfer Tests on 2300-Volt Station Auxiliary System, A. A. Johnson, H. A. Thompson, *AIEE Transactions*, 1950, Vol. 69, p. 386-394.

[10] Problems Encountered in Automatic Transfer of Large Induction Motors in Industrial Applications (Conference Paper CP-55-541) R. O. Bigelow, C. Auty, AIEE Summer General Meeting, Swampscott, Mass., June 27-July 1, 1955.

APPENDIX I
CALCULATING ACCELERATION TIME

Time to accelerate any machine =

$$t = \frac{WK^2 \times (N_2 - N_1)}{(T_d - T_l) \times 308}$$, Where

t = Time in seconds.

WK^2 = Moment of inertia of the complete rotating body, in pound feet squared.

N_2 = Final speed, in revolutions per minute.

N_1 = Initial speed, in revolutions per minute.

T_d = Torque capability of the driver, in pound feet.

T_l = Torque required by the driven machine, in pound feet.

Since both the torque capability of an induction motor and the torque requirement of most loads is not constant with changes in speed, a step-by-step solution is usually the most simple method of calculation, using small increments of speed change and average values of net accelerating torque over each speed range.

In an application where the driver and load operate at different speeds, the WK^2 of the load must be transferred to its equivalent at the motor shaft. The WK^2 of a high speed machine appears greater to the low speed shaft by a factor equal to the square of the speed ratio.

The above equation may also be used to determine decelerating characteristics when a motor is suddenly de-energized. The value $(T_d - T_l)$ is merely replaced by T_l. When considering deceleration during a heavy fault, an additional value of torque must be added which represents the power fed by the motor into the fault.

APPENDIX II
SPEED TORQUE CHARACTERISTICS OF COMMON REFINERY PUMPS AND COMPRESSORS

Centrifugal Pumps

The torque required by a centrifugal pump operating at no-flow conditions, or into a system composed largely of friction loss, varies approximately as the square of the speed. Normally 10 to 20 percent of full-load torque is required to break away a pump from standstill. Figure 2 illustrates the torque-flow characteristics of common refinery pumps operating at full speed.

Centrifugal Compressors

The torque required by a centrifugal compressor varies approximately as the square of speed for any fixed fluid system. By suction throttling, the torque at full speed can normally be reduced to as low as 20 or 30 percent of full-load torque on a radial-flow machine.

Reciprocating Pumps

The average torque required by a reciprocating pump is directly proportional to the differential pressure, regardless of pump speed. The instantaneous torque required reaches a peak value in mid-stroke which is greater than the average torque required, by a percentage which varies depending upon the type of pump. Unloading during starting is usually accomplished by means of a bypass valve which directs the pump discharge back to the suction line, thus keeping the average torque to less than 40 percent of full-load to torque.

Reciprocating Compressors

Motor-driven reciprocating compressors are normally unloaded to less than 40 percent of full-load torque, during the starting period, by means of suction valve lifters or bypass connections in the piping. Without unloading, the average torque required varies in a complex fashion with changes in the compression ratio, suction pressure, and gas composition. The ratio of peak instantaneous torque to average torque varies depending upon the compression ratio and the type of compressor. Calculation of the torque required by a reciprocating compressor under various conditions is beyond the scope of this paper.

NOMOGRAMS . . . Make Your Own

Part 1. How to prepare various types of scales

Part 2. Laying out the nomogram

Part 3. How to prepare different types of nomograms

Part 4. How to handle experimental data directly

Francis W. Winn
Fractionation Research, Inc.,
Alhambra, California

The Construction of a Nomogram with a Center Z-Scale. The procedure for constructing a nomogram with a center Z-scale from a linear coordinate plot is as follows:

(1) Draw a straight line equal in height to that available for the nomogram. Graduate and calibrate this line with the Y-scale.

(2) Draw another straight line equal in length and parallel to the first and separated (to the left or right) by a distance equal to the base available for the nomogram. Graduate and calibrate with the X-scale being sure that the direction relative to the Y-scale is such that a center Z-scale will be obtained, i.e., X and Y of the same direction if the slopes of the coordinate Z-lines are negative and vice versa.

(3) Locate the Z-scale stem by the method of intersecting construction lines through sets of coordinates of several values of Z throughout the range of values to be covered. Graduate the Z-scale by projecting from a smoothing plot.

(4) Add the proper legend to all scales, indicate the title of the nomogram and show the equation of the relation if available.

Examples

Example 1. Figure 5a is a plot of a family of parallel lines having a positive slope. The ordinate and abscissa are arithmetic, i.e., parallel and uniformly spaced. Transform the plot into a nomogram with the Z-scale between the X- and Y-scales.

Because the slope of the coordinate plot is positive, the X- and Y-scales are laid out in opposite directions. These scales are graduated by projections from arithmetic graph paper. A point on the Z-scale is located by the intersection of two or more sets of coordinates of one of the Z lines. Two such sets for Z = 64 are $(1.5, 0.5)_1$, and $(3.75, 2.75)_3$, i.e., (1) X=1.5, Y=0.5 and (3) X=3.75, Y=2.75. If desired, this point could be checked by another set of coordinates such as $(2.5, 1.5)_2$. The location of this nomographic Z-point, using temporary construction lines, is shown on Figure 5b. Also shown are the locations of sev-

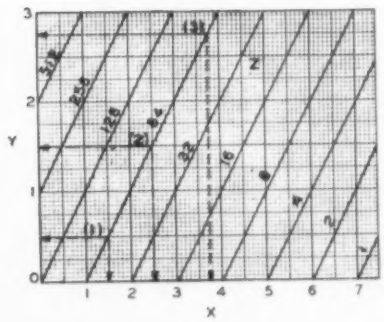


FIGURE 5a—Coordinate plot.

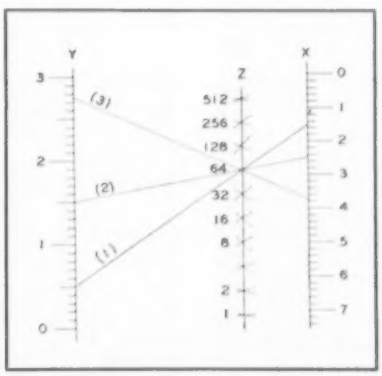


FIGURE 5b—How to construct Z-scale stem.

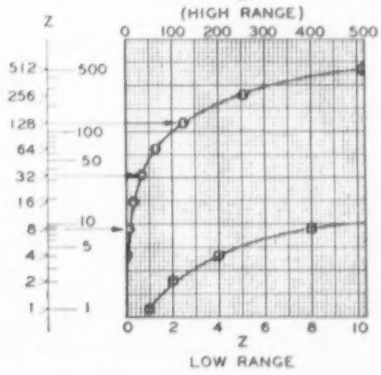


FIGURE 5c—Graduation of the Z-scale using arithmetic graph paper.

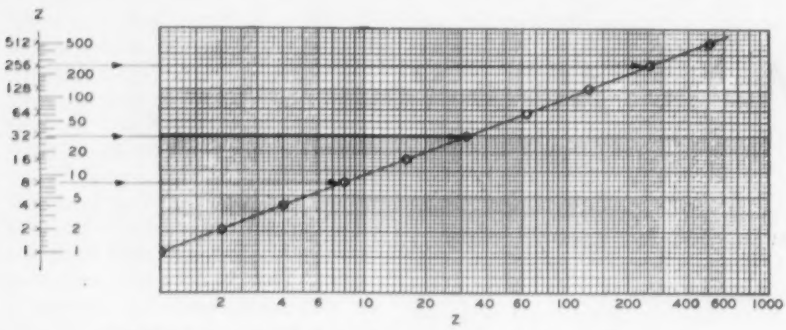


FIGURE 5d—Graduation of the Z-Scale using logarithmic graph paper.

eral additional Z-points. The subscripts 1, 2, and 3 above identify the temporary construction lines on Figure 5b.

A curve drawn through the various Z-points is the Z-scale stem. As explained before, the stem is straight and parallel to the X- and Y-scales because it corresponds to a coordinate family of parallel lines.

A sheet of arithmetic graph paper is attached to the board and the vertical lines are calibrated for the range of Z-values given in the coordinate plot. The Z-points from the Z-scale stem are projected to corresponding vertical lines of the graph paper and the resulting points are circled. A line is drawn through the circled points. This line is curved because the graduation of the Z-scale is not uniform. However, it may be used to project the graduation marks back to the Z-scale as indicated in Figure 5c. A more accurate graduation is obtained by using an expanded plot for the lower values as illustrated.

If a sheet of logarithmic graph paper is used in place of the arithmetic graph paper the projected points fall on a straight line as indicated in Figure 5d. Straight lines are preferred because of greater accuracy and ease of construction; hence the choice of graph paper which gives the least curvature in the projection step is the more desirable.

Example 2. Figure 6a is a log-log plot of a family of parallel lines having a negative slope. Transform it into a nomogram with the Z-scale between the X- and Y-scales.

Since the slope of the parameter (the family of Z-lines) is negative, the X- and Y-scales are laid out in the same direction. These scales are constructed by projections from logarithmic graph paper. Temporary construction lines are again used to establish the Z-scale stem. By inspection the graduation of the Z-scale appears to be uniform; hence arithmetic graph paper is used in the projection step to establish the finished graduation of the Z-scale. These steps are indicated in Figure 6b.

Example 3. The two preceding examples were for families of parallel lines and the corresponding nomograms consisted of three parallel scales. Consider Figure 7a which is a plot of a family of lines which converge to the point (1, 2). Each Z-line is numbered with its slope. Convert this figure to a nomogram

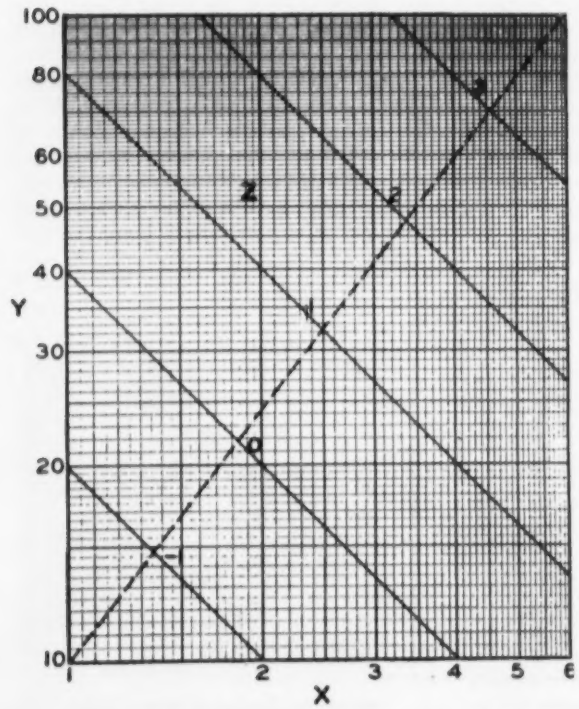
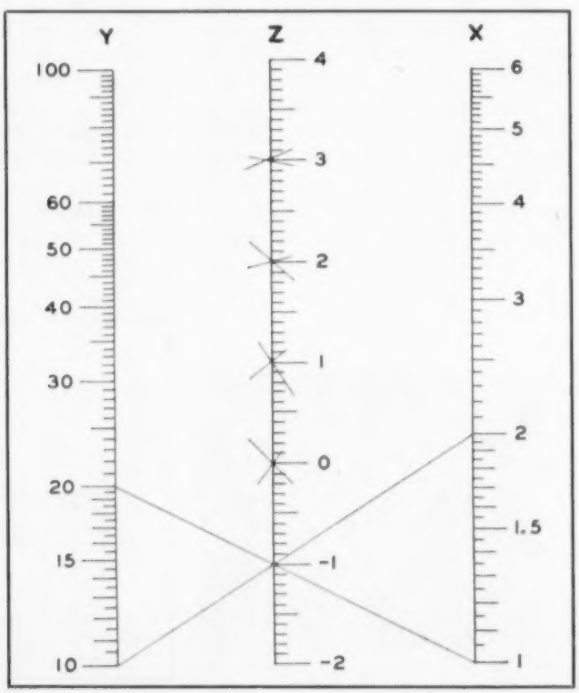


FIGURE 6a . . .



. . . FIGURE 6b

How to lay out Example 2.

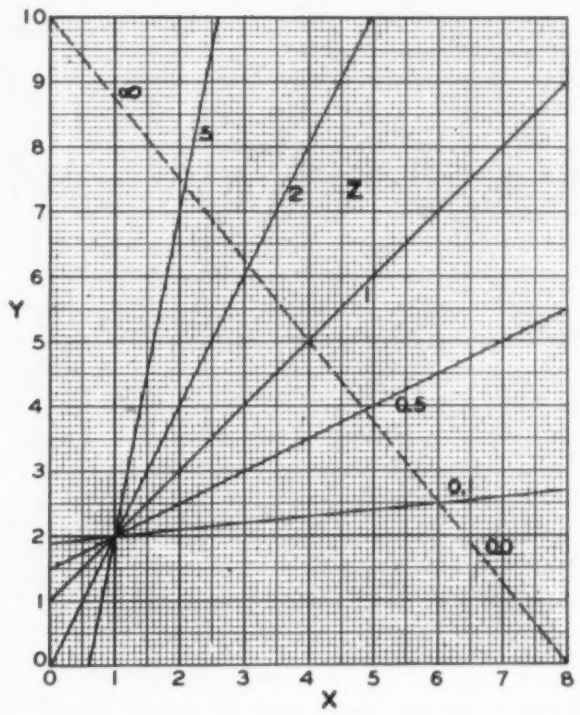
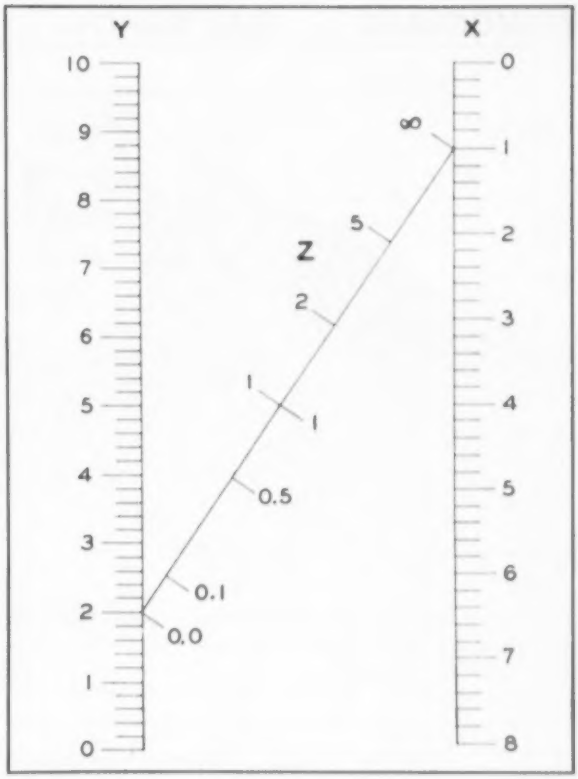


FIGURE 7a . . . How to layout Example 3. . . . FIGURE 7b



with the Z-scale between the X- and Y-scales.

The X- and Y-scales are laid out in opposite directions because the slopes of the parameter lines are all positive. The Z-scale stem could be located by finding several nomographic Z-points using temporary construction lines through sets of coordinates of the various coordinate Z-lines. However, it is known that the Z-scale stem is straight because the parameter of coordinate Z-lines converges to a point. Since the coordinates of this point, (1, 2), are common to all of the individual lines of the parameter the Z-scale stem must fall on a line drawn between the X- and Y-scales at X = 1 and Y = 2.

It is necessary to locate several Z-points on the Z-stem before the projection step can be used to graduate the Z-scale. The partially finished nomogram is shown in Figure 7b. It will be noted that Z = 0 lies on the Y-scale and that Z = ∞ lies on the X-scale.

Geometric Transformation of a Rectilinear Plot into a Nomogram. The method just described for constructing a nomogram with a center Z-scale does not require the actual construction of a linear coordinate plot (it is only necessary to know that such a plot could be drawn if desired). The following method does require the preliminary construction of a linear coordinate plot. It is particularly useful for visualizing and sketching the basic form of a nomogram.

The procedure consists of drawing a straight diagonal across the coordinate plot in a manner such that it cuts each member of the ordinate, abscissa and parameter. The intersections of the diagonal with ordinate lines are projected to a straight scale stem, resulting in the Y-scale. The intersections of the diagonal with the abscissa are projected to another straight scale stem which is parallel to the first, resulting in the X-scale. The Z-scale stem is located by the method of intersecting construction lines or by other methods. The intersections of the diagonal with the parameter lines are projected to the Z-stem resulting in graduation of the Z-scale.

The diagonal which connects the upper left hand corner of the coordinate plot to the lower right hand corner will cut all members of each family for a parameter having a positive slope. Likewise, the diagonal connecting the lower left to the upper right corners will cut all members of each family for a parameter having a negative slope.

Example 4. Figure 6 illustrates this procedure for a family of lines having a negative slope. The diagonal is the dotted line. One may readily visualize how the Y-axis is projected horizontally to the straight line representing the Y-scale. Likewise, the vertical abscissa lines intersect the diagonal at points which may be projected horizontally to the X-scale. Also, after the Z-stem is located, the intersection of the diagonal with the Z-lines on the coordinate plot may be projected to the Z-scale. Only the Z-lines —1, 0, 1, 2, and 3 may be projected as these are the only ones drawn on the coordinate plot. It is necessary to attach another sheet of graph paper to the board and use it as a projection plot before the intermediate graduations of the Z-scale can be placed. This latter step is not illustrated.

Figure 7 shows the diagonal which is used to construct the nomogram corresponding to a parameter having a positive slope.

The Construction of a Nomogram with a Center X- or Y-Scale. In the special case of a coordinate family of parallel Z-lines, the construction of a nomogram with a center X- or Y-

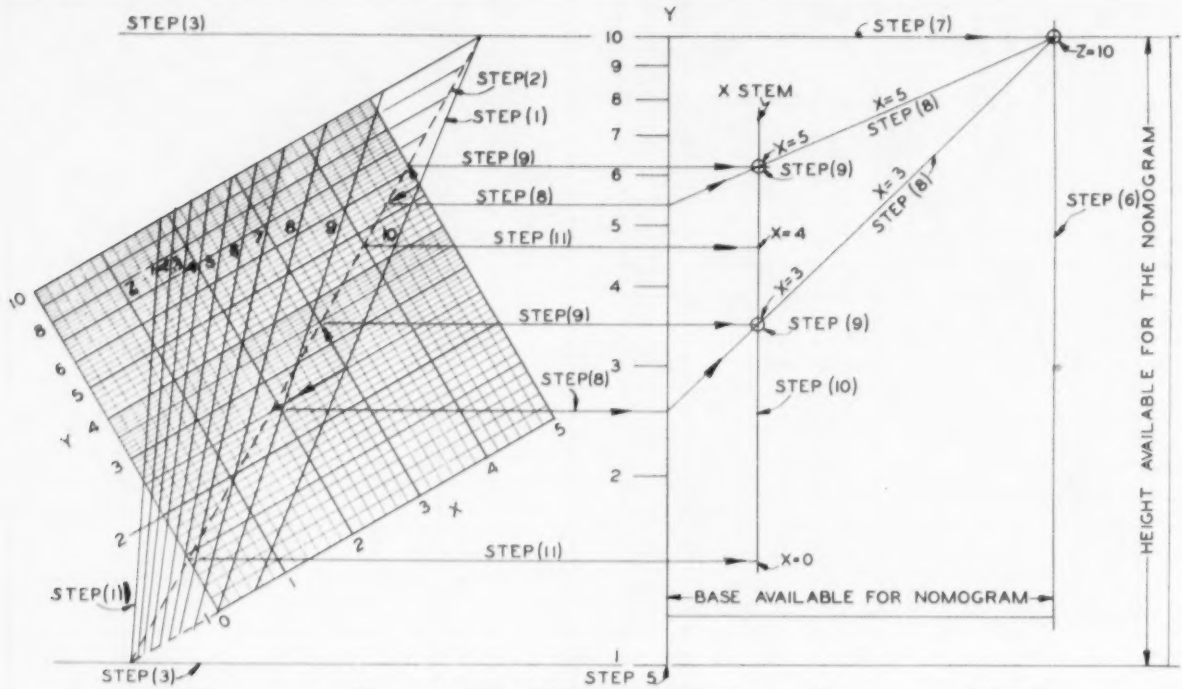


FIGURE 8a . . . The case of a non-parallel Z-Scale with a parallel center scale. . . . FIGURE 8b

scale is no problem. It is necessary to lay out the Y- (or X-) and Z-scales in the proper direction on parallel stems equal in length to the height of the nomogram and use the resulting scales to locate the X- (or Y-) scale by the method of intersecting construction lines.

If the coordinate Z-family is not parallel, the procedure to obtain a center X-scale is as follows: (See Figure 8).

(1) Construct the linear coordinate plot of the relation and extend the Z-lines and Y-lines so that all of the Y-lines are cut by each of the Z-lines.

(2) Connect the extended extremes of these lines with a straight diagonal. This diagonal will cut each X-, Y-, and Z-line of the coordinate plot.

(3) Draw on a blank sheet of paper two horizontal parallel lines separated by a distance equal to the height of the nomogram.

(4) Orient the coordinate plot so the extremes of the diagonal from step (2) touch the two parallel lines of step (3).

(5) Draw the Y-stem perpendicular to the horizontal lines of step (3). Project the intersections of the Y-

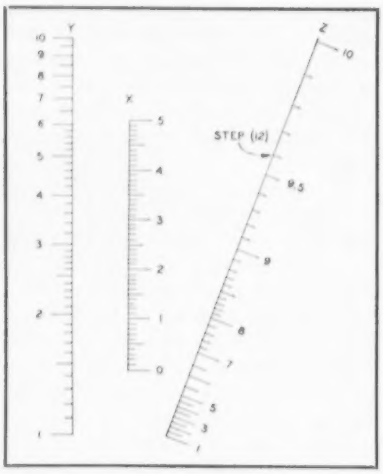


FIGURE 8c

family of lines with the diagonal of the coordinate plot to the Y-stem resulting in the Y-scale.

(6) Draw a temporary line parallel to the Y-scale separated to the left or right by a distance equal to the base of the nomogram.

(7) Project the intersection of the diagonal of step (4) with the Z-line having the lowest slope, horizontally to the line of step (6). The resulting point is the nomographic Z-point and normally is at either the bottom or top of the nomogram.

(8) Connect the Z-point of step (7) to several values along the Y-scale with temporary construction lines and label with the corresponding values of X.

(9) Project these values of X from the diagonal of step (4) to the corresponding construction lines of step (8) and circle the points of intersection. These points should fall on a straight line which is parallel to the Y-scale stem.

(10) Draw a line through the points of step (9) and extend to the top and bottom of the nomogram.

(11) Project the remaining values of X from the diagonal of step (4) to the X-stem, resulting in the X-scale.

(12) Use the X- and Y-scales to determine additional points along the Z-scale and use a projection smoothing plot to finish the graduation.

The procedure to obtain a center Y-scale is analogous to that for the X-scale except the Z-lines and the X-lines are extended as in step (1) so that all of the X-lines are cut by each of the Z-lines.

Part 4 will appear in a coming issue.

New Way to Clean Up Fuels

This is a progress report concerning a process for the removal of wax, dirt and water from fuels.

P. J. McGuire and H. A. Price
Dorr-Oliver, Inc., Stamford, Conn.

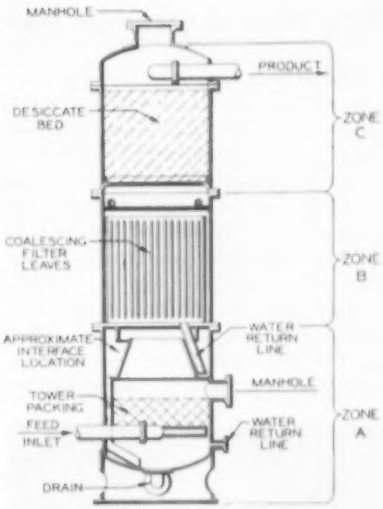


FIGURE 1—The latest design incorporates three zones within a single unit.

THERE IS a general trend toward heavier fuels in today's market. This is increasing the demand on manufacturing and marketing facilities for a better solution to the problem of providing, at the customer level, fuels that are dry and free from suspended waxes, gums and dirt.

In heavier fuels, the precipitation of wax and gum increases greatly after a certain period of storage. While this precipitation will vary with different stocks, it is often impossible to avoid a storage period of damaging length.

When this fine precipitation does occur, there are few satisfactory methods of fine filtration to remove the wax and gum accumulation or of coalescing any moisture haze that accumulates in the stock during the storage period. It is difficult also to handle the heavier stocks inside the refinery proper when it is necessary to remove cloud or haze due to entrained caustic and water after caustic treatment.

All of the presently available methods for contaminant removal by coalescence and filtration have serious defects when streams having viscosity similar to diesel fuel are approached, especially when the interfacial tension has dropped to the 25 dyne/cm range. This is particularly true of fuels in the JP4 and JP5 jet fuel ranges.

A three-step process, consequently, has been developed, each step to be carried out in a separate zone of a single unit. The locations of these three zones in a unit of present design is shown in Figure 1.

The scrubbing zone (A) is essentially a water wash scrub tank. In this zone, any large slugs of water are immedaitely removed and the entrained water passes from the hydrocarbon to the water phase. The scrubbing action in the tower packing and water bath also causes waxes, gums and dirt to develop sticky surfaces. These collide, seed, and grow due to the increase in hydrocarbon velocity induced by venturi action near the top of the zone.

Also, in passage through the interface, electrostatic charges are developed that supplement and assist this seeding action and particle growth. These flocculated particles drop out at the water hydrocarbon interface for later removal with the water draw-off.

The coalescing zone (B) provides a large surface area with wide interior passageways to permit coalescing and filtering at low velocities and prevent redispersion of coalesced material. The coalescer-filter element itself is made up of a number of wide, flat rectangular filter leaves supported from a single header plate. This is handled as a unit when new leaf covers are needed. The leaf covers are of a fine fiber to achieve coalescing and are protected by several layers of coarser filter media. In operation, these coarser layers will stop and partially discharge the suspended particles deposited on the outer media surface.

As it is built into large droplets, the coalesced moisture is removed on either side of the coalescing media, and leaf construction is designed to promote rapid and free separation of moisture from the hydrocarbon stream. The coalesced water drops while the hydrocarbon rises to Zone C. Moisture can either be removed automatically from Zone B of the rectifier or automatically returned to Zone A, depending upon operating conditions.

The polishing zone (C) is a desiccate bed of a type commonly found in refinery practices. Half-ground salt, similar to that used for final dehydration, is used as an effective desiccate material. In addition to acting as a moisture barrier, this rock salt bed gives a final polish to the clean hydrocarbon. At the same time, any brine formed by salt dissolution through moisture reaching the bed is automatically returned to either Zone A or B for removal with other moisture.

Where rock salt is not entirely suitable because of local conditions, other types of desiccate material may be substituted. However, treated papers were found to be unsatisfactory due to failure under shock loads. The rock salt bed, on the other hand, was totally effective under varying conditions.

The prototype unit, shown in Figure 2, was physically dissimilar to the present design in some respects; however, it embodied all the basic principles. Results obtained from its trial run at a commercial bulk distributing

plant provided data which not only proved the effectiveness of the three-zone principle but which were of great value in finalizing the design.

The prototype unit was constructed with the main tower 48-inches in diameter and approximately 17 feet high. Its coalescer-filter elements were in the form of 14 circular cans which were located in the 8 foot diameter circular ring surrounding the upper part of the tower. The interior of this ring was connected to the tower by

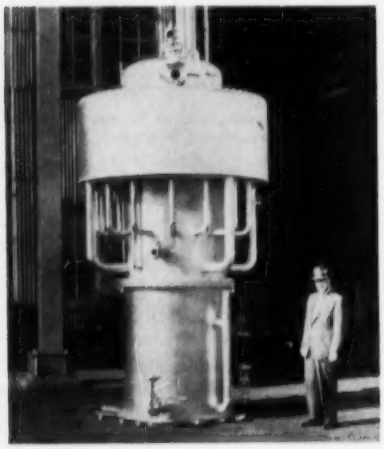


FIGURE 2—This prototype includes basic design principles but differs physically in some respects from present design.

riser and down-comer pipes so arranged that the hydrocarbon going up into this Zone B had to pass through the coalescer-filter media on the outside of the circular filter elements in order to return to the main body of the tower. The same type of media contemplated for the finished design was used and therefore the process and sequence of operations are comparable. However, the prototype unit had less than ¼ of the coalescer-filter area provided in the present design.

Actual operation of the unit extended over several months at a bulk plant receiving premium grade gasoline by barge. The fuel was passed through the unit and delivered from the outlet line directly to the truck for distribution. During this period of operation over 2¾ million gallons of premium gasoline were handled through the unit.

When cleaning premium grade gasoline, the nominal capacity of this unit was 1000 gallons per minute. The highest rate used was 1200 gallons per minute. Up to its maximum capacity, there was no detrimental effects in running the unit at any desired rate.

The normal repairs stopped on station and truck meters in the area covered from this particular bulk station when the prototype unit was put in operation. When the unit was taken out of operation, meter service returned to a normal frequency with overhaul required about every 150,000 gallons.

The coalescer-filter elements collected dirt which was 40 to 50 percent iron oxide. When some of the leaf covers were cut through, the under surfaces were white and clean showing that no dirt reached the coalescing media. It is estimated that 80 percent of the dirt never reached the filter zone but was removed in Zone A.

On an average basis, 20 to 40 gallons of water was removed per day from 40,000 to 65,000 gallons of premium grade gasoline. That the unit was doing a good job of moisture coalescence and removal is shown by the fact that there was no noticeable consumption of salt from the desiccate bed during this entire operation. The level of the salt at the finish of the operation measured within ½-inch of its level at the start. The depth of the salt bed in Zone C, in the prototype was approximately four feet.

The success of the trial runs of the prototype unit on high-grade aviation gasoline plus results from pilot tests on numerous other grades and types of hydrocarbon fuels indicate that the process can be successfully applied commercially in many areas. A number of successful test applications have been completed by the U. S. Navy, U. S. Air Force, and several major oil companies.

Based on these pilot tests, full-scale field installations are being made for final evaluation of the process and various unit designs under the following specific conditions:

- Clean jet fuel for military use
- Caustic haze removal from diesel fuel in a refinery
- Moisture and dirt removal from heavy kerosine
- Moisture, dirt, and H_2S removal from feed to a natural gasoline plant
- Clean fuel oil for Naval use

In the meantime, basic research and development work is being continued and further specific problems of hydrocarbon clean-up are being worked on. It is expected that this area of investigation will be broadened still further as members of the industry bring up their own particular problems.

This program has been greatly assisted and expedited by the technical staffs and other personnel of many of the major manufacturers and marketers of these fuels. Various staff members of the Shell Oil Company, Standard Oil Company of California, Tide Water Assocaited Oil Company, Union Oil Company and others, have provided assistance and advice on design. They have also collaborated in development by supplying stocks for pilot runs as well as full-scale operation and by free exchange of engineering data.

Meet the Authors

McGuire

Price

PHILIP J. McGUIRE has been with the Dorr-Oliver organization some 38 years. In 1924, after six years in Denver with the former Dorr Company, he moved to Los Angeles and a year later joined the former Oliver United Filters organization. Since the merger of the two companies a year ago, he has been director of filtration product development. McGuire is a 1915 graduate of Colorado School of Mines.

HAROLD A. PRICE joined the Dorr-Oliver organization in 1954 as a consulting engineer. Previously, he had been with Byron Jackson Pump Company, Standard Oil Company, The Bahrien Petroleum Company, Ltd., Bechtel Corporation, the Navy's Bureau of Yards and Docks and Rucker Company. Educated at the University of Southern California and the University of California, he is a registered marine engineer and a registered mechanical engineer.

The short way to . . .

Gas Absorption Calculations

. . . using a graphical diagram procedure even for multicomponent mixtures. Allowance is made for varying liquid to gas ratios throughout the column. Three sample problems are solved for you.

S. R. M. Ellis,
University of Birmingham,
Birmingham, England

AS MOST GAS absorption columns operate with a varying liquid to gas ratio the operating line on a McCabe Thiele diagram is curved when the vapour and liquid compositions are expressed as weight or mole fractions. Allowance for this varying liquid to gas ratio can be made by using a Y-X diagram where the gas composition is expressed as pounds of solute per pound of inert gas and the liquid composition as pounds of solute per pound of absorbing liquid. The McCabe Thiele construction can thus be applied provided the inerts are insoluble in the liquid and the solvent is non volatile.

In the selective absorption of hydrocarbon components from a multicomponent gas mixture, where all the components have some degree of solubility in the absorbing oil, Sherwood[1] uses a modified McCabe Thiele construction by curving the equilibrium line to compensate for the curved operating line.

It is the purpose of the author to suggest a simple graphical procedure as an alternative to the Sherwood method. The proposed method uses weight or mole fractions and an uncorrected equilibrium value (K) at the mean tower temperature. The difference point construction is used and allowance is made for a varying liquid to gas ratios throughout the column.

The Difference Point Construction—Numerous graphical procedures have been proposed for calculating the number of equilibrium stages in counter current mass transfer operations. In the field of distillation Ponchon[2] and Savarit[3] use an enthalpy concentration difference point construction. This method allows for varying molal overflow and so takes into account heats of mixing, varying molal latent heats, etc.

The method can only be used, however, in the limited number of cases in which the requisite enthalpy data are available. The author[4] has recently suggested a modification of the Ponchon and Savarit construction by using a reflux—concentration diagram for evaluating the number of equilibrium stages under conditions of constant molal overflow. This method is of particular value in tray to tray analysis in ternary and multicomponent systems since a graphical construction is used for each individual component.

The difference point construction has also been extensively used in liquid-liquid extraction calculations. Nash and Hunter[5] have used triangular graph paper, whereas Thiele,[6] Randall and Longtin,[7] Treybal,[8] Maloney and Schubert,[9] and other workers have used rectangular co-ordinates.

The difference point i.e. the point of intersection of the operating lines can be defined as follows by reference to Figure 1.

Total material balance:

$$L_o + G_n = L_n + G_1 \quad \ldots\ldots\ldots\ldots (1)$$

Material balance for any component:

$$L_o x_o + G_n y_n = L_n x_n + G_1 y_1 \quad \ldots\ldots (2)$$

The net flow towards stage n

$$\Delta = L_n - G_1 = L_1 - G_2 = L_{n-1} - G_n = L_o - G_n \ldots (3)$$

Since the net flow from stage to stage is equal there should be on a reflux-concentration diagram a common point of intersection of the operating lines. The above relationship

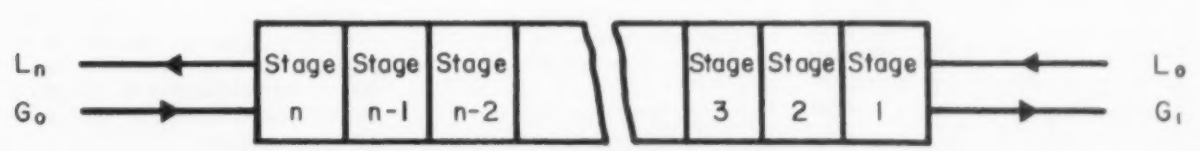


FIGURE 1

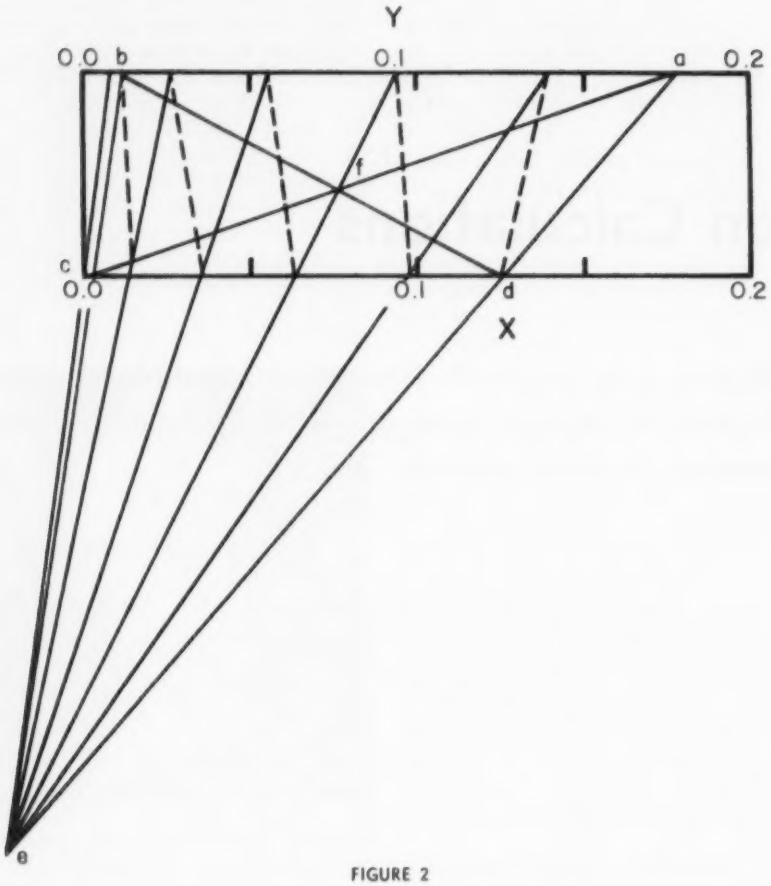


FIGURE 2

holds for varying molal overflow.

The net flow of any component towards stage n.

$$L_o x_o - G_1 y_1 = L_n x_1 - G_2 y_2 = L_{n1} x_{n-1} - G_n y_n = L_o x_n - G_o y_o \quad . . (4)$$

If the difference in mass of any particular component is divided by the corresponding difference in total streams the resulting difference in mass fraction is a co-ordinate of the difference point.

$$(x) \Delta = \frac{L_{n-1} x_{n-1} - G_o y_o}{L_{n-1} - G_o} = \frac{L_o x_n - G_o y_o}{L_n - G_o} \quad . . . . . (5)$$

This equation applies to each component and so the difference point can be located.

Absorption of Ammonia in Water—The following example is taken to illustrate the use of the difference point constructions in calculating the number of equilibrium stages in a gas absorption column.

Example 1. One hundred thousand cubic feet per hour of gas containing 23.2 percent of ammonia by volume (remainder air) are to be scrubbed with water to remove 95.0 percent of the ammonia. The process is isothermal at 30 C. and the pressure is 760 mms. The water entering the column at a rate of 7530 pounds per hour is free of ammonia. How many equilibrium stages are required?

Constant L/G Construction—The above problem may be summarised as follows:

Amount of Air entering G'_o
= 5585 lbs/hr.

Ammonia content of gas entering
= 0.177 lbs/lb of air.

Amount of Air leaving G'_1
= 5585 lbs/hr.

Ammonia content of gas leaving
= 0.0089 lbs/lb of air.

Amount of water entering L'_o
= 7530 lbs/hr.

Amount of water leaving L'_n
= 7530 lbs/hr.

Ammonia in water leaving
= 0.125 lbs/lb of air.

The equilibrium data are taken from *Elements of Chemical Engineering*, Badger and McCabe.[10]

The number of equilibrium stages is shown in Figure 2.

Gas (Y) and liquid compositions (X) are drawn parallel at any convenient distance apart. The composition of the gas stream entering is designated by a and the gas stream composition leaving by b. The liquid composition entering is c and the liquid composition leaving d. By joining a d and b c and extrapolating the operating lines to intersect at a common difference point e. the ratio of air to water passing at any point in the column is given by

$$\frac{G'_o}{L'_n} = \frac{ed}{ea} = \frac{G'_1}{L'_n} = \frac{ec}{eb} = \frac{5585}{7530} = 0.74$$

The overall material balance can also be expressed as

$$\frac{G'_1}{L'_n} = \frac{fd}{fb} = \frac{G'_n}{L'_n} = \frac{fc}{fa} = \frac{5585}{7530} = 0.74$$

The number of equilibrium stages is determined by stepping between the operating lines and equilibrium lines. The equilibrium lines are shown as dashed lines in Figure 2. For this problem the number of equilibrium stages is five which is in close agreement with the McCabe Thiele construction.

Varying L/G Construction—The same problem may be summarized as follows:

Amount of gas entering G_n
= 6577 lbs/hr.

Ammonia % in the entering gas
= 15.1% by wgt.

Amount of gas leaving G_1
= 5637 lbs/hr.

Ammonia % in the exit gas
= 0.92% by wgt.

Amount of water entering L_n
= 7530 lbs/hr.

Amount of solution leaving L_n
= 8470 lbs/hr.

Ammonia % in the exit solution
= 11.1% by wgt.

The number of equilibrium stages is shown in Figure 3.

Gas (y) and liquid compositions (x) are again drawn parallel to any convenient distance apart. The composition of the gas stream entering is given by a and the gas stream composition leaving by b. The liquid composition entering is c and the liquid composition leaving d. It will be noted that c d is not parallel to a b and e can be located by one of the following two procedures.

(1) The over-all balance is ex-

pressed by joining c a and dividing at f such that.

$$\frac{G_o}{L_o} = \frac{fc}{fa} = \frac{6577}{7530} = 0.872$$

The point b is joined through f to d such that.

$$\frac{G_i}{L_o} = \frac{fd}{fb} = \frac{5637}{8470} = 0.665$$

The operating lines through b c and through a d are extrapolated to intersect at the difference point.

Alternatively

(2) join b to c and extrapolate to c such that

$$\frac{G_i}{L_o} = \frac{ce}{be} = \frac{5637}{7530} = 0.746$$

(e) can also be located by Equation (5) and the extrapolation of b c. Next join c to d such that d is the point on this operating line at the final solution composition. Join c d.

The number of equilibrium stages is determined by stepping between the operating lines with the dashed equilibrium lines. Liquid compositions are determined from the intersection of the operating and equilibrium lines on the line c d. The number of equilibrium stages from Figure 3 is 5.

Multicomponent Hydrocarbon Absorption—Apart from the fact that Figure 1 is entirely a straight line construction and any convenient scale can readily be selected there is no great advantage for this method over the McCabe Thiele graphical construction. In fact it might be argued that the latter method gives a clearer picture of the plate to plate composition changes. The disadvantage of Figure 1 and of the McCabe Thiele construction is that these methods are not directly applicable to multicomponent hydrocarbon absorption problems where all the components are to some extent soluble in the absorbing oil and where this oil may be volatile.

Sherwood[1] curves the equilibrium line to compensate for the effect of the changing gas and liquid rates. The equation for constructing the equilibrium lines is as follows

$$\frac{Y}{X} = K\frac{(1+\Sigma Y)}{(1+\Sigma X)} \quad \ldots\ldots(6)$$

where

Y = lbs or moles of solution per pound or mole of inlet gas.

X = lbs or moles of solution per pound or mole of absorbing liquid.

ΣY = sum of Y values for components in the gas phase.

ΣX = sum of X values for components present in the liquid phase.

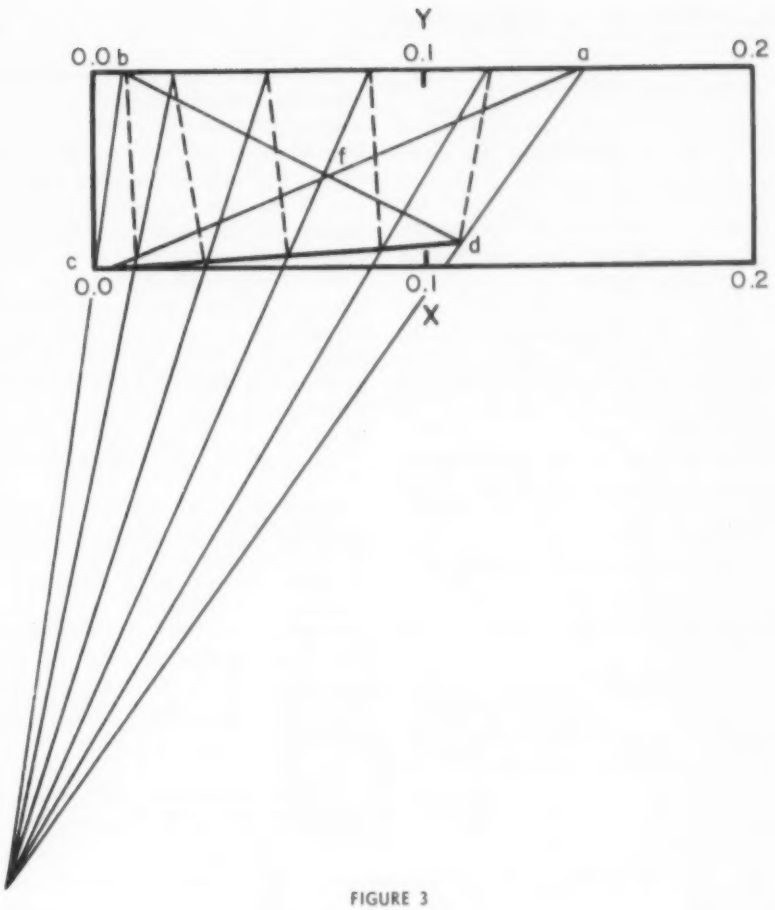


FIGURE 3

To apply this relationship points are evaluated on both ends of the equilibrium curve, and thus from the lean end and rich end slopes, the equilibrium curve is completed by fitting to each end a regular French or Ship curve. It is claimed that this procedure is justified by the fact that the curvature of the equilibrium line is not appreciable.

The straight line construction shown on Figure 3 can be simply and readily applied to multicomponent absorption problems and it is proposed to illustrate this application by considering an example. Edmister[11] considers the application of the Sherwood method to the following problem.

Example 2. A 30-plate absorber operates at 60 psig treating 18 million sfc per 24 hour, of a gas containing 83 percent methane, 8.4 percent ethane 4.8 percent propane, 0.9 percent isobutane, 1.7 percent n-butane, 0.4 isopentane, and 0.8 percent n-pentane. The tower will be supplied with 3 million gallons per 24 hours of a denuded oil having a specific gravity of 0.8251 and an average molecular weight of 161. The tower will operate with an average oil temperature of 90 F. Assume an over-all plate efficiency of 20.0 percent. Find the recovery of each component in the wet gas.

Edmister[11] first applies the absorption factor method to find the fractions absorbed and thus the compositions of the rich and lean gas leaving the column. Two absorption factors are used, firstly $A = \frac{L_o}{K_{av} \cdot G_o}$ and secondly $A = \frac{L_o}{K_{av} G_o}$ where L_o is the number of moles of lean oil entering the column, L_n is the number of moles of rich oil leaving the column, and G_o is the number of moles of rich gas entering the column. Table 2 summarizes the results using the second absorption factor and Figure 4 shows the quantities entering and leaving the column.

For the key component i-pentane the Sherwood graphical construction gives an absorption figure of 6.95 moles/hour. The column has six the-

oretical stages and requires a $\frac{L}{G}$ ratio of 0.2705. The amount absorbed is in close agreement with the values of 7.03 moles per hour on Table 2. If absorption of the key component had been much different, another calculation would have been necessary to adjust total absorption.

Difference Point Construction—An alternative graphical construction to the Sherwood method for the key component i-pentane is shown on Figure 5.

As outlined in the preceding example for ammonia and water the material balance can be expressed in various ways.

(1) Join c b and extrapolate to c such that

$$\frac{be}{ce} = \frac{L_o}{G_1} = 0.281$$

Point a can be located by the intersection of e d on the feed inlet composition line $y_o = 0.04$. The accuracy of the construction can be checked for

$$\frac{ae}{ce} = \frac{L_o}{G_o} = 0.303$$

Gas or y compositions are taken vertically from the y line on to the varying reflux line a b where the equilibrium and operating lines intersect.

(2) The over-all material balance can be expressed by joining b d and dividing at f such that.

$$\frac{fb}{fd} = \frac{L_o}{G_o} = 0.303$$

Point a is then located by extrapolating f c to a to intersect the vertical inlet composition $y_o = 0.04$ and such that

$$\frac{fa}{fc} = \frac{L_o}{G_1} = 0.281$$

Equally the construction could have been commenced by joining e d to cut the horizontal gas composition line at $y_o = 0.04$. Point b would then be located by the intersection of e c and the vertical exit composition line. Point b would then lie above the gas composition line y. From Figure 5 six theoretical stages absorbs 7.0 moles of i-pentane.

Multicomponent Hydrocarbon Stripping—The same construction as shown on Figures 3 and 5 can be applied to stripping problems. The following example of Edmister[11] is taken to illustrate the method.

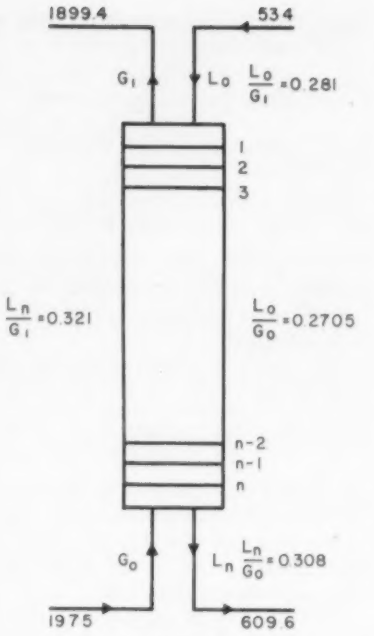


FIGURE 4

Example 3. Find the recovery of each solute component by stripping a rich oil with 4500 pounds of steam per hour in a 24-plate stripper operating at 135 psig. Assume an over-all plate efficiency of 25 percent. The analysis of the rich oil and of the composition of the stripped vapor is shown on Table 1.

TABLE 1

COMPONENT	Moles/Hr. in Rich Oil	Moles/Hr. Stripped
Methane	11.76	11.76
Ethane	6.93	6.93
Propane	12.88	12.88
i-Butane	6.18	6.18
n-Butane	15.80	15.64
i-Pentane	7.03	6.61
n-Pentane	16.01	13.69
	75.59	73.69

The number of moles per hour stripped is evaluated by applying the absorption factor method to six theoretical trays and the problem remaining is to check more accurately for the key component n-petane whether or not this recovery is feasible for six theoretical trays in the column.

The quantities and compositions of the vapor and liquid streams entering and leaving the column is summarized on Figure 6.

The graphical construction for the

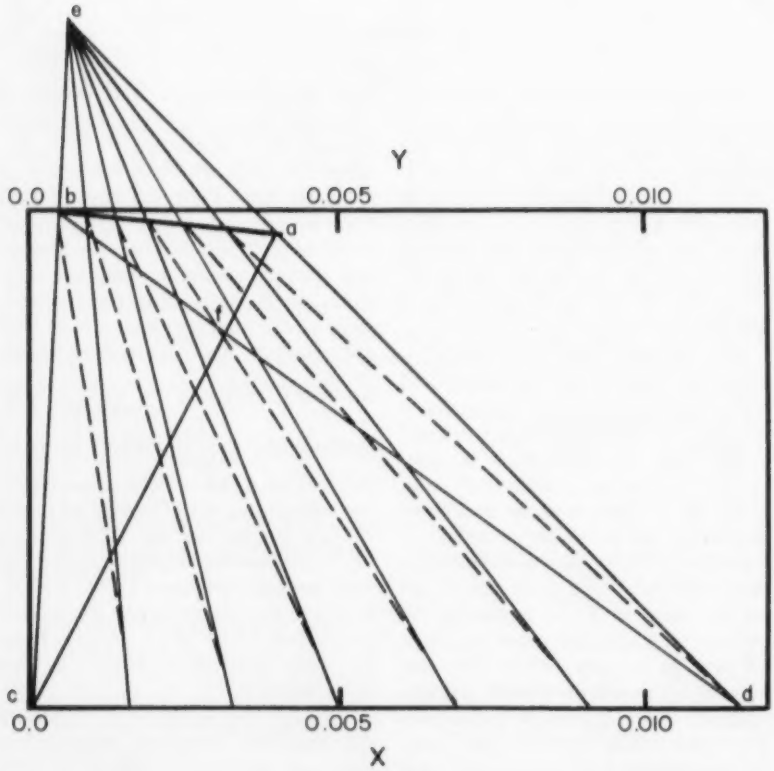


FIGURE 5

Meet the Author

S. R. M. ELLIS, in addition to teaching chemical engineering at England's University of Birmingham, also supervises design problems in the Department of Chemical Engineering and does some research work for the school. A veteran of 12 years experience in the design and operation of chemical plants, Dr. Ellis joined the university faculty in 1947. He was educated in England and his native New Zealand, and received both his master's and his doctor's degrees from Birmingham. A previous article by Dr. Ellis was published in the PETROLEUM REFINER in September 1954.

number of equilibrium stages for the composition changes given in Figure 6 is shown on Figure 7. The inlet stream composition b is joined to the exit liquid composition c and extrapolated to e the difference point such that

$$= 0 \cdot 465 \qquad \frac{ce}{be} = \frac{S_o}{L_n} = \frac{250}{535 \cdot 9}$$

Join e a to cut the inlet liquid composition line of 2.46 percent n-pentane at d. Join c d. The equilibrium ratio for n-pentane at 35.8 F. and 135 psig is 2.2. The number of equilibrium stages is between 6.0-7.0 and thus the absorption factor calculation must be repeated to give a slightly lower recovery of n-pentane for six theoretical stages.

This type of construction can be made to any convenient scale and since it is entirely a straight line construction the method is both rapid and accurate. As the method is on a weight or mole fraction basis a similar construction can be used for other components and in both stripping and absorption problems a graphical tray to tray analysis can if required be made. The above method can also be applied to liquid-liquid extraction.

NOTATION

Y = lbs or moles of solute per pound or mole of inlet gas.

X = lbs or moles of solute for pound or mole of absorbing liquid.

K = equilibrium ratio.

G = gas flow rate in pounds or pound moles per hr.

L = liquid flow rate in pounds or pound holes per hr.

y = weight or mole fraction in gas phase.

x = weight or mole fraction in liquid phase.

LITERATURE CITED

[1] Sherwood, T. K., "Absorption and Extraction," McGraw Hill.

[2] Ponchon, M., Tech Moderne 1921, 13, 20.

[3] Savarit, R., Arts et Metiers 1922, 65, 142, 178.

[4] Ellis, S. R. M., Chem. Eng. Sci., 1954, 3, 287.

[5] Nash, A.W., and Hunter, T. G., J. Soc. Chem. Ind. 1934, 53, 95.

[6] Thiele, E. W., Ind. Eng. Chem., 1935, 27, 392.

[7] Randall, M. and Longtin, B., Ind. Eng. Chem. 1938, 30, 1063, 1188, 1311.

[8] Treybal, R. E., "Liquid Extraction," McGraw Hill, 1951.

[9] Maloney, J. O., and Schubert, A. E., Trans. Amer. Inst. Chem. Eng. 1940, 36, 741.

[10] Badger, W. L., and McCabe, W. L., McGraw Hill. 1936.

[11] Edmister, W. C., Pet. Eng., 1947, p55.

TABLE 2

COMPONENT	y_o	G_o Moles/Hr. in.	$A = \frac{L_n}{K_{no}G_o}$	Moles/Hr. Absorbed	G_1 Moles/Hr. Out	y_1
Methane	0.830	1639.2	0.00718	11.76	1627.44	0.8240
Ethane	0.084	165.8	0.04185	6.93	158.87	0.0805
Propane	0.048	94.9	0.1358	12.88	82.02	0.0416
i-Butane	0.009	17.8	0.3470	6.18	11.62	0.00590
n-Butane	0.017	33.6	0.4700	15.8	17.80	0.00902
i-Pentane	0.004	7.9	1.0909	7.03	0.87	0.00044
n-Pentane	0.008	15.8	1.3580	15.01	0.79	0.00040
	1.00	19.75	....	75.59	1899.41	.....

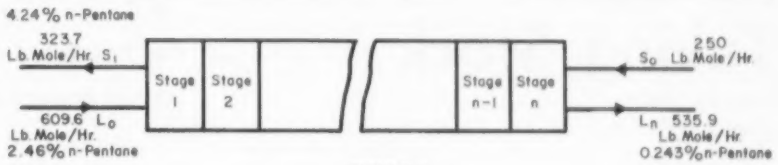


FIGURE 6

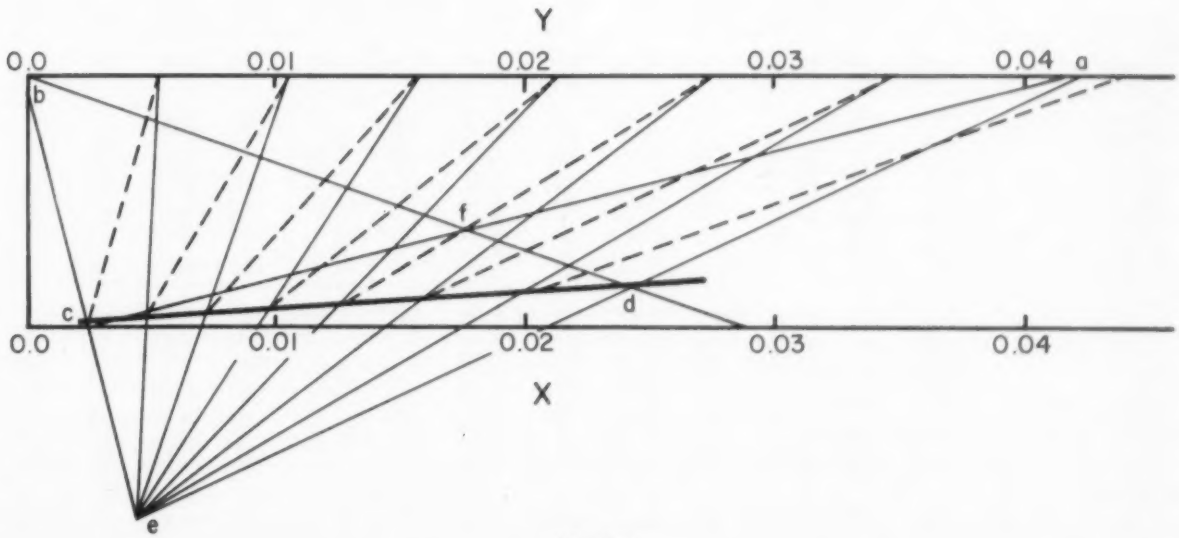
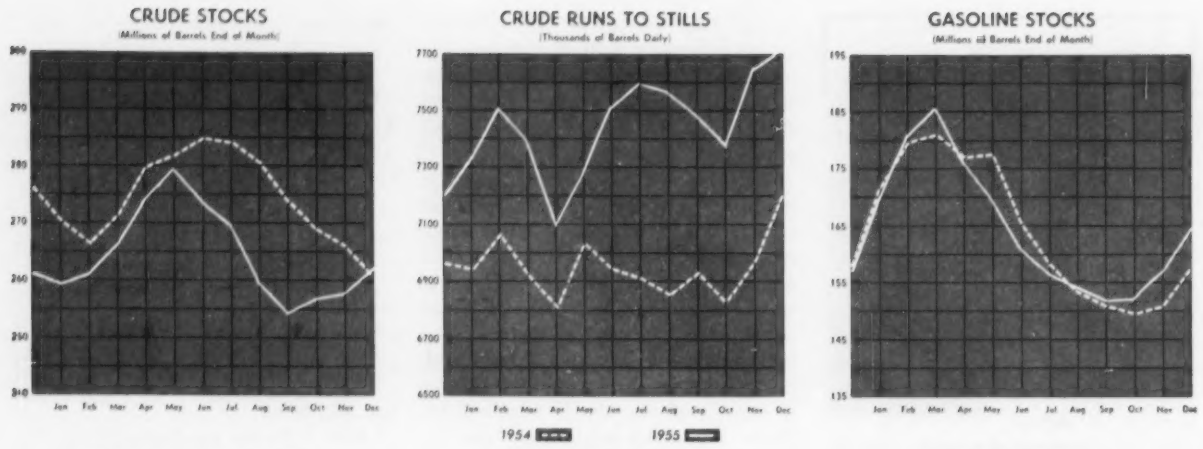
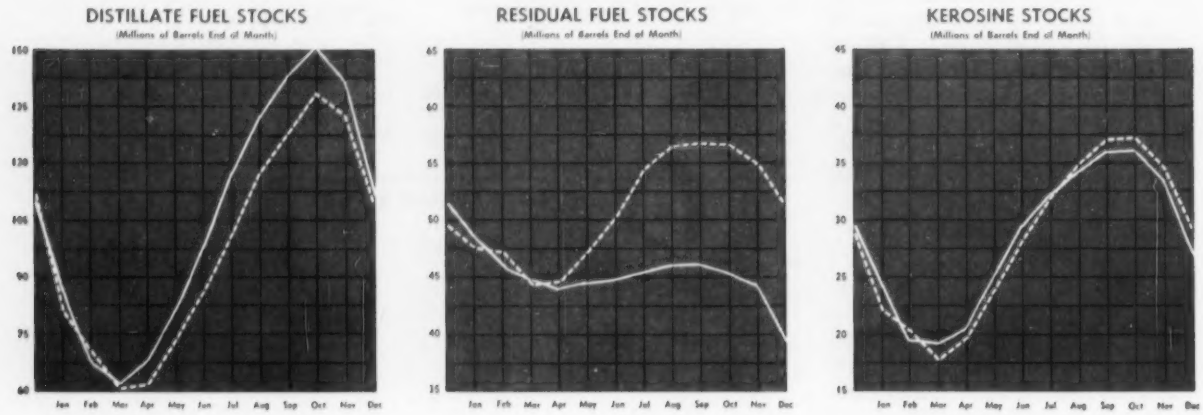


FIGURE 7




DISTILLATE FUEL STOCKS
(Millions of Barrels End of Month)
RESIDUAL FUEL STOCKS
(Millions of Barrels End of Month)
KEROSINE STOCKS
(Millions of Barrels End of Month)

Taking Stock

Cecil W. Smith,
Economics Editor

- Refinery activity at all-time peak
- Distillate stocks under last year's
- Oil imports reach a new high mark

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1953:													
November	6,277	6,987	283,021	3,528	150,747	354	36,271	1,463	133,381	1,223	51,267	648	1,120
December	6,238	6,964	276,676	3,628	159,949	378	29,070	1,441	111,944	1,247	49,370	598	1,121
1954:													
January	6,240	6,947	270,811	3,431	171,704	390	22,013	1,467	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	412	20,183	1,545	70,390	1,241	47,119	621	1,144
March	6,507	6,923	271,867	3,375	181,297	353	17,533	1,458	60,270	1,168	44,249	654	1,088
April	6,615	6,811	280,310	3,404	177,006	322	19,656	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	302	23,892	1,372	73,581	1,148	47,009	708	1,021
June	6,500	6,947	285,155	3,483	165,404	306	28,184	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	295	31,953	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	302	34,949	1,453	117,579	1,069	56,332	664	966
September	6,151	6,939	274,608	3,511	150,916	301	37,099	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	310	37,140	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	354	34,547	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	381	27,826	1,668	108,144	1,187	52,105	729	1,301
1955:													
January	6,761	7,379	260,156	3,639	169,562	409	23,266	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	374	18,291	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	357	18,187	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	312	21,486	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	296	26,375	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	269	29,830	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	286	32,749	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	290	35,292	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	279	36,361	1,621	143,248	1,061	46,267	829	1,218
October	6,837	7,465	267,346	3,827	153,103	309	36,705	1,612	152,288	1,123	47,040	821	1,206
November	6,831	7,663	257,713	3,756	156,949	333	33,534	1,682	141,609	1,175	44,410	829	1,266
December	6,955	7,769	262,033	3,856	164,859	360	27,437	1,772	112,792	1,343	39,872	880	1,453
Week Ended:													
1–20–56	7,045	7,952	258,864	3,795	175,785	375	22,711	1,939	94,610	1,331	39,012	681	1,267
1–21–55	6,695	7,179	257,705	3,495	166,285	375	26,118	1,751	95,870	1,163	49,931	631	1,106

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

Gas Conditioning Today

What the problems are and how they're being solved . . .

Part 1: Particulate Matter Removal and Gas Purification

Part 2: Dehydration

A. L. Kohl and F. C. Riesenfeld
The Fluor Corporation
Los Angeles

RECENT DEVELOPMENTS in gas conditioning may affect your present installations. Dehydration, in particular, has commanded considerable interest both in maintenance and process design. Here are some of the problems and how they're being solved.

Special Developments. A rather special development in the field of gas treating which has been disclosed during recent years may be mentioned. In one application of this system, a gas stream containing very large amounts of acid gases, up to 90 percent, was treated with a concentrated aqueous amine solution. The purpose of this operation was to absorb the acid gas in a minimum volume of solution so that it could be transported by truck to a regenerator located at some distance. Because of the very high heat of reaction evolved in this process, a special scheme was devised which consisted of absorbing the bulk of the gas by concurrent mixing with the solution in a water cooled heat exchanger, followed by countercurrent absorption of the final traces. This system operated quite successfully and is described by Bechtold and Kohl.[23]

During the latter part of 1954 the Amine-Salt process was disclosed. This process, according to its inventor, has the benefit of appreciably reduced corrosion of regeneration equipment and reduction of chemical losses.[24]

Finally, considerable progress has been made in the development of techniques for more accurately designing absorption and stripping columns. The rate of absorption of CO_2 in aqueous MEA solutions, which involves simultaneous absorption and chemical reaction, has been studied quite extensively,[25] and plate efficiency correlations have been developed to serve as a new tool for the process designer.[26]

Dehydration. The subject of natural gas dehydration has received considerable attention in the recent literature, as there are several excellent articles describing the general problems and techniques used to remove moisture from gases.[27, 28, 29, 30, 31, 32] No attempt will be made to discuss these. However, certain recent developments need to be evaluated.

A primary purpose of gas dehydration is to prevent the formation of hydrocarbon hydrates which can plug valves and transmission lines. Another purpose is to prevent the condensation of liquid water in transmission lines as this can reduce line efficiency and, in the presence of acid gases, can lead to very severe corrosion. A very spectacular case of gas transmission line corrosion has been described recently by Paredes and Mize of El Paso Natural Gas Company.[33]

If maximum dehydration and consequently very low dew points are required, dry desiccants are the only means by which this can be achieved. The initial installation cost of dry desiccant type plants operating at pressures of 500-1000 psi is about twice that of a plant using liquid drying agents. Furthermore, the use of conventional dry desiccants appears to be definitely uneconomical if the gas temperature is above 100° F., and precooling of the gas to at least 100° F. is necessary.[34]

In order to reduce the initial cost and the operating expenses of solid dehydration systems, high capacity desiccants are desirable. A recent development in this direction is activated alumina H-151 which is said to be capable of absorbing water to the extent of 12 percent of its weight after extended use.[35] This figure is based on operating conditions of 600 psi and higher and a water content of the gas at the saturation point of 7 pounds per million cubic feet. The material is very tough and the attrition losses are very low. Data have also recently been presented on field tests of a granular silica gel[36] dehydrating natural gas. These tests showed the material to have an initial capacity of about 22 percent water which dropped to about 11 percent after one year's service.

The use of Socony Mobil's beads for natural gas dehydration is well established and will not be discussed at

this time. Because all of the solid desiccants are subject to a reduction in capacity with continued use, a design loading of about 6 percent water per cycle is typically used.

An interesting, very recent development is the introduction of the so-called molecular sieves.[37] These molecular sieves are crystalline, sodium and calcium alumino-silicates with controlled pore sizes which will absorb molecules of a certain size and reject molecules larger than the pores. These materials are reported to have very high capacities for water, on the order of 18-20 percent by weight, and are capable of dehydrating gas at elevated temperatures (200° F. or more). However, they do have the disadvantage that quite high temperatures are necessary for the complete removal of the water from the adsorbant.

While ordinary desiccants such as Bauxite and silica gel are essentially water free at temperatures on the order of 350-400° F., temperatures as high as 600-700° F. are necessary to completely strip the molecular sieves of their water. At present, insufficient information is available on the use of molecular sieves so that a final evaluation of these materials will have to be made in the future.

The most widely used system for pipe line gas dehydration involves the use of polyhydric alcohols, especially diethylene glycol (DEG) and triethylene glycol (TEG). Although DEG is most commonly used, TEG has found many applications in recent years. The reason for this change is that TEG is thermally more stable than DEG and can therefore be used in higher concentrations. It is possible to employ TEG solutions containing as little as 2 percent water without vacuum regeneration and, consequently, to obtain dew point depressions up to 65° F. By using vacuum regeneration systems, relatively low regenerator temperatures can be maintained, and water concentrations of the solution can be reduced to a few tenths of 1 percent.

The corresponding dew point depressions are on the order of 100° F.[38] The low vapor pressure of TEG permits operation with chemical losses on the order of 0.1-0.25 pound per million cubic feet of gas, which is about one half of the losses incurred with DEG under comparable conditions. As stated above, TEG is considerably more stable than DEG and it is reported that at temperatures of approximately 400° F. TEG decomposes at about one-sixth of the rate of DEG. The decomposition products are mostly vapors which are removed in the regenerator. Both DEG and TEG can be freed from heavy decomposition products by redistillation under vacuum.[39] The decomposition of DEG and TEG and corrective measures to prevent it has been investigated by several authors.[10]

The results of this work indicate that the decomposition of the glycols is due primarily to oxidation and that addition of MEA, phosphates and buffers appears to be effective in reducing corrosion caused by decomposition products. Successful use of the corrosion inhibitors in glycol systems has also been reported.

Glycol amine systems containing MEA and DEG or TEG are comparable in their dehydration capacity with glycol solutions of the same water content. The selective amine, MDEA, can also be used in combination with glycol and selective H_2S removal, and simultaneous dehydration can be effected.

In recent years, interest in the protection of gas gathering lines against corrosion and hydrate formation has increased. As a result, many operators now dehydrate gas at the wellhead. In most cases, it is not necessary to dehydrate wellhead gas as completely as transmission line gas, and a dew point depression of 45° F. is satisfactory. This permits the economical use of glycol systems even for gases of relatively high temperatures. Since relatively small volumes of gas are involved in these operations, they are very well suited for the application of fully automatic package type units. A large number of these units are operating very successfully in many gas fields in this country. Finally, the injection of hydrate preventing agents such as alcohol and glycol is practiced to some extent. It seems that injection of glycol is more economical; however, this technique involves the disadvantage of glycol removal from the line, reconcentration, and transportation to the injection point.

Summarizing the progress made in the technology of gas conditioning during the past few years, the following conclusions are indicated:

- In the field of particulate matter removal, major emphasis has been on the development of techniques for evaluating equipment performance, and a growing tendency toward very high efficiency removal of all particles is apparent.
- Gas purification technology has been advanced by the introduction of several new systems to minimize chemical losses, corrosion and steam consumption. The corrosion problem is still present to some extent, and additional work is being conducted.
- Regarding dehydration, recent developments include the introduction of new, high capacity solid adsorbants and the use of more concentrated glycols, particularly TEG, in liquid dehydration plants.
- The future will undoubtedly bring increased automation of gas conditioning operations. There are already instruments available for the continuous recording of dew points and hydrogen sulfide content of gases. It is only one step further to the combination of these with control instruments of advanced design now available, for fully automatic plant control.

LITERATURE CITED

[23] Bechtold, I. C., and Kohl, A. L., U. S. Patent 2,607,657.

[24] "Electric Mercaptan and Amine Salt-H_2S Processes," Oliver J. Sandona and Charles W. Rippie, Pet. Eng., Nov., 1954, p. C-43.

[25] Perry, R. H., and Pigford, R. L., Ind. Eng. Chem., Vol. 45, p. 1247, 1953.

[26] "Plate Efficiency With Chemical Reaction—Absorption of CO_2 in Monoethanolamine Solutions," A. L. Kohl; presented at 47th Annual Meeting of the AIChE, New York, December 12-15, 1954.

[27] "Dehydration of Natural Gas and Light Hydrocarbon Liquids," J. N. Campbell and L. L. Laurence, Petroleum Refiner, Vol. 31, No. 8, p. 65, August, 1952.

[28] Ibid, Vol. 31, No. 10, p. 107, Oct., 1952.

[29] Ibid, Vol. 31, No. 11, p. 109, Nov., 1952.

[30] Ibid, Vol. 32, No. 1, p. 139, January, 1953.

[31] Ibid, Vol. 32, No. 2, p. 131, Feb., 1953.

[32] Ibid, Vol. 32, No. 3, p. 151, March, 1953.

[33] "Hydrogen Blisters in Gas Transmission Lines, and Preventive Methods," F. Paredes and W. W. Mize, presented at Ninth Meeting of the Petroleum Division of ASME, September 26-29, 1954, Los Angeles, California.

[34] "Methods for Gas Dehydration for 1954," J. N. Campbell, Pet. Eng., Vol. 26, No. 10, Sept., 1954.

[35] "H-151—Alcoa's New Form of Activated Alumina," Alcoa bulletin.

[36] "Natural Gas Dehydration With Silica Gel," Robert H. Herrmann; presented at Gas Conditioning Conference, March, 1955, University of Oklahoma.

[37] "Molecular Sieves for Selective Adsorption," Linde Air Products Company bulletin.

[38] "Dew Point of Gas in Equilibrium With Concentrated Glycol Solutions," L. D. Polderman, presented at Gas Conditioning Conference, March, 1955, University of Oklahoma.

[39] Polderman, L. D., Gas Conditioning Conference, 1954, University of Oklahoma.

An acknowledgment and earlier literature cited appeared with Part 1, January 1956 REFINER.

Ratio-Delay Observation Sheet

	8 a.m.	9 a.m.	10 a.m.	11 a.m.	12 noon	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.
Tuesday, 30th Nov.										
Total Observations		18 15	22	18		22 18	26 30	20	24 24 21	
Men Working		11 9	12	9		12 13	14 17	14	18 16 16	
Men Not Working		7 6	10	9		10 5	12 13	6	6 8 5	
(a) Loitering		7 6	6	7		6 5	7 9	4	6 7 3	
(b) Stores		0 0	2	2		1 0	1 0	1	0 1 —	
(c) Crib		0 0	2	0		3 0	4 4	1	0 0 2	
Wednesday, 1st Dec.										
Total Observations		24 37	20 35	19 28			19	27		
Men Working		17 22	10 26	9 15			15	15		
Men Not Working		7 15	10 9	10 13			4	12		
(a) Loitering		3 15	8 7	10 12			2	11		
(b) Stores		2 —	2 0	— —			—	1		
(c) Crib		2 —	2	— 1			2	0		
Thursday, 2nd Dec.										
Total Observations		27	36	31 16 29		21 26	23 20	25 25		
Men Working		16	20	23 10 18		15 18	16 13	15 19		
Men Not Working		11	16	8 6 11		6 8	7 7	10 6		
(a) Loitering		7	13	5 4 10		3 4	4 4	6 3		
(b) Stores		2	2	2 1 0		2 2	2 1	2 2		
(c) Crib		2	1	1 1 1		1 2	1 2	2 1		
Friday, 3rd Dec.										
Total Observations		18 25	14	25		24	25	25 28	29	
Men Working		12 15	2	16		13	16	20 15	10	
Men Not Working		6 10	12	9		11	9	5 13	19	
(a) Loitering		6 5	12	8		9	8	5 13	17	
(b) Stores		0 3	0	0		2	1	0 0	1	
(c) Crib		0 2	0	1		0	0	0 0	1	

FIGURE 2—Ratio delay or work sampling observation sheet used to record activity data as obtained in the field.

(Note: The recorded observations under the hour headings only indicate they were taken between that hour and the next.)

How Effective Is Your Maintenance Dollar?

Use statistical activity sampling.

- **Part 1-Evaluate your current reports.**
- **Part 2-Evaluate by work sampling.**
- **Part 3-Evaluate by craft measurements.**

A. N. Smith
Steinbergs Ltd., Montreal

LET US LOOK deeper into the fog that normally clouds the whole maintenance function. It probably will result in some reports being received with a jaundiced eye and being not entirely believed. As such, it may cause some doubts on the value of such documents in handling the maintenance business.

Nevertheless, if consideration of these reports is always tempered by the realization that they illustrate what maintenance conditions *are* and not what they *should be*, they will still serve a useful purpose.

How you can analyze certain existing reports in order to attempt to identify ineffectiveness was covered by Part 1. The word "report" should be stressed. There sometimes is a tremendous difference between paper or reported conditions and actual status.

Now it is important to realize that there is a difference between how "busy" a maintenance man is and how "effective." For example, a man may be quite busy puttering around and yet accomplishing virtually nothing. You might, if you studied him, give him high marks for adherence to the job, yet give him nothing for his accomplishment.

Mind you, a man *cannot* be effective without being busy but he can be busy without being effective. Therefore, if you want a rough assessment of maintenance efficiency, find out what level of activity exists. Actual efficiency will be always lower than this.

You can get this information if your budget will stand it by time-study but this is obviously very costly. Fortunately, there is an alternative to time-study which is only about one quarter as expensive and which is called "ratio-delay" or "work sampling."

You can, with no previous experience and with no extra help, make such a study and accumulate valuable data. You find out by this procedure what ratio any sort of delay holds to the total assigned time and conversely the ratio of actual working time. What is more, employes in the group being studied, will know nothing of your efforts.

This technique is actually an extension and refinement of an older technique known as "head count." In taking a head count, an observer walks through a working area and counts the number of men who are working and the number who apparently are not working. The ratio of men working to total men observed, then, is considered to represent the average percentage of workers' time devoted to productive effort.

The work sampling refinement uses simple statistical methods to determine the accuracy of these percentages and

Summary Sheet

TOTAL	LOITERING		TOOL CRIB		STORES		NOT WORKING	WORKING	
	Accumulated No.	Percentage	Accumulated No.	Percentage	Accumulated No.	Percentage		Accumulated No.	Percentage
18	7	39	—		—		7	11	61
33	13	39	—		—		13	20	61
55	19	34.5	2	3.6	2	3.6	23	32	58.3
73	26	35.6	4	5.5	2	2.7	32	41	56.2
95	32	33.7	5	5.3	3	3.2	40	55	57.8
121	39	32.2	6	5.0	7	5.8	52	69	57.0
17	44	31.6	6	4.3	7	5.0	57	82	59.1
1[illegible]	55	32.6	10	5.9	7	4.1	72	97	57.4
etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.
etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.
etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.
810	228	28.2	37	4.6	35	4.3	300	510	62.9
824	240	29.1	37	4.5	35	4.2	312	512	62.4
849	248	29.2	38	4.5	35	4.1	321	528	62.4
873	257	29.4	38	4.4	37	4.2	332	541	62.1
898	265	29.5	38	4.2	38	4.2	341	557	62.2
923	270	29.3	38	4.1	38	4.1	346	577	62.4
951	283	29.7	38	4.0	38	4.0	359	592	62.2
980	300	30.2	39	4.0	39	4.0	378	602	61.7

FIGURE 3—Summary sheet used to accumulate and summarize data from observation sheet.

to determine whether variances in successive periods are significant or not.

The experience which others have placed at our disposal is drawn on in work sampling. The earliest reference to ratio-delay is 1935 when L.H.C. Tippett applied the technique in the English textile industry. Somewhat later, in 1940, Professor R. L. Morrow of New York University presented a paper on the subject to the annual meeting of the American Society of Mechanical Engineers. Since then, the method has been the subject of considerable study on this continent but, despite its proven advantages, its use in American and Canadian industry has not been widespread.

However, there has been a renewal of interest in the last several years, and several large corporations are presently using it.

While ratio-delay, or Work Sampling as we prefer to name it, studies may be applied equally well to machine operations or employe performance, this discussion will be restricted to applications involving activity of groups of people, such as a maintenance organization.

In the group being studied, the working status of each individual noticed is recorded at random intervals. If a sufficiently large number of observations are taken, the percentage number of readings, that record employes as working, will tend to equal the percentage time that they are in that state. By the same reasoning, if inactivity is classified into various types, the time spent at each type of inactivity will be indicated by the percentage of observation recorded for each type.

The classes of inactivity that concern you most will depend, of course, on the operation being studied. "Loitering" will undoubtedly rank high on your list; waiting time at the tool crib may be another; waiting time at store dispensing counter may also be another and so on. Whatever tends to produce non-productive time can be a logical target for such a study.

Previously, some mention was made of random observations. The importance of correctly using random readings cannot be overemphasized. If observation times are not truly random but are, for instance, chosen to suit the convenience of the observer, incorrect sampling will be the result. These random times may be procured from tables of random numbers, or from a numbered deck of cards or from a blank scale marked on at random which, then, requires a superimposed scale to point out the sampling time. There are numerous ways of determining the observations, but all serve to make the sample of human activity as perfect as possible.

Here, it is advisable to advise that anticipation must be guarded against. Your observations must "freeze" each man studied. You cannot allow yourself to be influenced by what he has just done or what he is about to do. It is only important what he is doing at the moment of observation.

In order to prevent uncertainty as to how an observer should record a man's status, it is necessary for certain arbitrary decisions to be made. For instance, is a man working when he is talking to his foreman? How about, if he is talking to the plant manager? Is he working or not, if you catch him halfway between his lathe and the bench where his tool box is kept? These are typical of the questions you should resolve before you make your study. It is not too important, how you decide, as long as you, and other observers, are consistent.

Certain rules have been indicated that must be adhered to if your results are to mean anything. It is only necessary to add that the recording and tabulation of your results is important also, if you wish to make proper analysis. Here is a brief description of the various steps. They cover the development of the following:

1. The sample size and accuracy.
2. The sampling technique which includes rate of observations and the time of these.
3. The observation sheet.
4. The summary sheet.
5. The analysis sheet.

1. Sample Size:

(a) To determine the number of observations required, use the formula:

$$N = \frac{T^2}{E^2} P(1 - P)$$

Where
N = number of spot checks to be taken
E = prescribed maximum error expressed in the same units as the sample average (see note on Maximum Error 1 (b)
T = a chosen constant for a given probability (refer to Table A)
P = estimated frequency of the element under investigation. (Usually estimated by taking a small random sample—about 25—at the start of study)

TABLE A

Probability	T
0.90	1.65
0.95	1.96
0.99	2.33

(b) **Maximum Error:**

Most articles that have appeared in recent technical journals have prescribed a maximum error of ±5 percent for all ratio delay studies. This should not be followed blindly. For example:

1. If you are measuring an element of very low occurrence, say 4 percent, it is not logical to worry about a maximum error of only ±5 percent. It may be much greater.
2. Even the briefest check will show you that as you in-

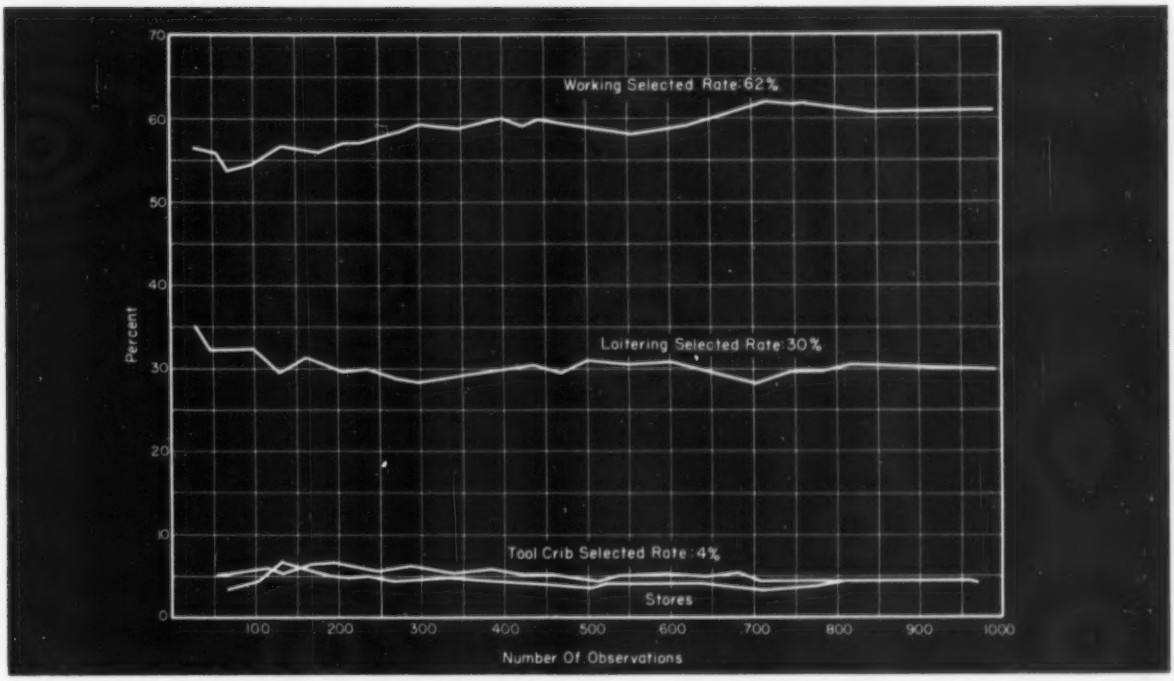


FIGURE 4—Analysis chart for plotting summary percentages to graphically develop trends over a long time period.

crease the maximum error allowed, the number of observations will be decreased.

(c) **Typical Problem:**

A random sample of 25 observations indicated the percent working time to be 60 percent. How large a sample should be taken to give a 95 percent probability that the actual value lies within an error interval of ±3 percent.

Substituting in the formula Where

$$N = \frac{T^2}{E^2} P(1-P) \qquad \begin{matrix} T = 1.96 \text{ (Table A)} \\ E = (0.03 \times 0.60) \\ P = 60\% - 0.60 \end{matrix}$$

$$1 - P = 1.00 - 0.60 = 0.40$$

$$= \frac{(1.96)^2}{(0.03 \times 0.60)^2} \quad (0.60) \times (0.40)$$

$$= 2845 \text{ checks}$$

But if an error interval of ±7 percent was satisfactory

$$N = \frac{(1.96)^2}{(0.07 \times 0.60)^2} (0.60) \times (0.40)$$

$$= 523 \text{ checks}$$

2. Having decided upon the number of observations in your sample, you are, then, governed by the recommended length of the study. If you wish your results within two weeks, you divide the number of observations by 10 (working days) to give the daily assignment. This is, in turn, divided by the average number of employes you are likely to scan in each reading and will give you the number of readings each day. Using random times, then, each reading is taken and recorded on the observation sheet. (Figure 2).
3. The use of the observation sheet requires little explanation. It is essentially a work sheet for recording the result of each reading.
4. The use of the summary sheet also should be easy to comprehend. Figure 3 shows a typical sheet.
5. The results on the summary sheet are plotted on an analysis sheet. Trends soon become clear and, when all fluctuations stabilize, a sufficient number of readings have been taken. This point will generally be reached at approximately the calculated number of observations. The analysis sheet is shown in Figure 4.

On just making such a study of your maintenance department, it may surprise and may even shock you to find that, in what you had fondly imagined to be a reasonably efficient and hard-working shop, a working percentage of only 65 percent. This figure, low as it is, should not be too disturbing. That figure would appear to be an average condition. This principle is generally accepted by many, who have studied maintenance activity.

Certain large organizations go somewhat further. They reconcile "activity" and "effectiveness" by subtracting 10 to 15 points from a percentage reading of activity, determined by work sampling, to obtain a measure of effectiveness.

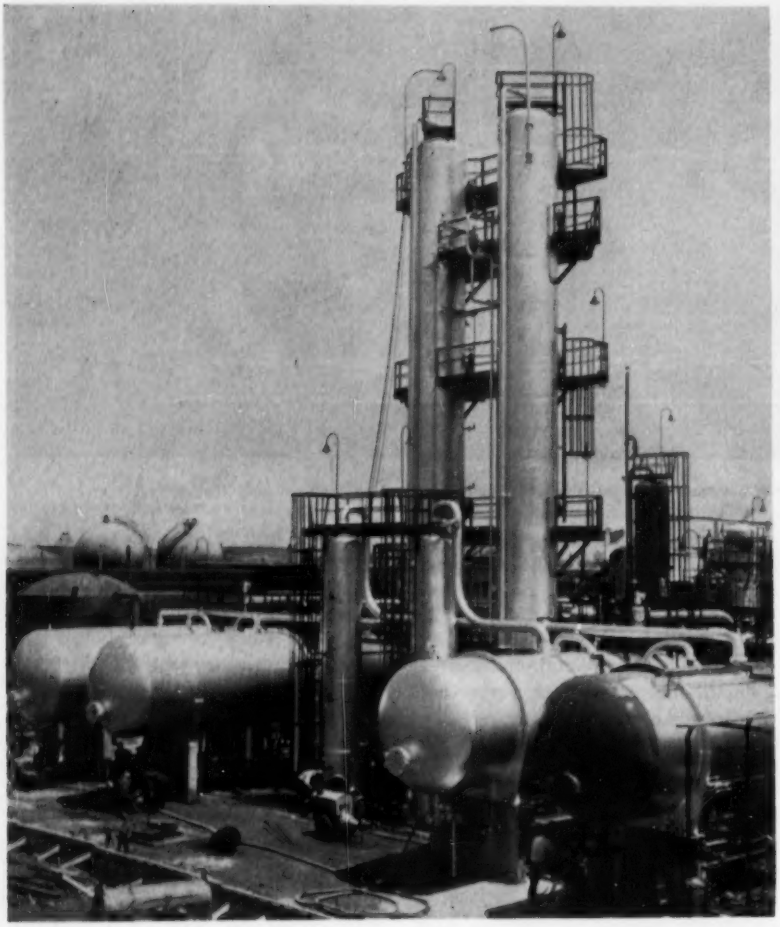
What can you do with these results? The work sampling technique supplies information only. What you do with these facts determines whether or not the method will pay off. The obvious steps of reducing wasted time will usually be undertaken. And, of course, further work sampling studies will guide your future action.

What are the potential savings of reducing this lost time? It is not hard to calculate. Assume you find, by work sampling, that your maintenance organization is "enjoying" a 65 percent activity level. This is, as has been pointed out, an average figure. Therefore, your company is getting *at the most* no return for 35 percent of the money it allocates to maintenance. The chances are that it will be much less than that when effectiveness is considered. However, disregard this and only look at activity.

Although 100 percent activity is not attainable, it should be possible to reach a figure of, at least, 85 percent. Therefore, your savings calculated from the difference between 85 percent and 65 percent, or any part of it, should be very worthwhile.

Part 3 will appear in an early issue

Sulfur Compounds From Petroleum



A gasoline treating unit.

Occurrence • Synthesis • Uses

Lewis F. Hatch
University of Texas

THE FACT that sulfur-containing compounds occur in petroleum has been known for a long time. The fact that these compounds and their derivatives can be turned from liabilities to assets is only now being realized.

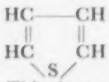
The basic concern of the refiner in the past has been to remove or destroy these sulfur compounds rather than to recover and utilize them. This is easily understandable because sulfur compounds present corrosion problems both during refining and in product utilization; many of them are malodorous; they depress octane number and decrease lead susceptibility and adversely affect product stability, buring characteristics, etc.

The problem of isolation and identification of the different classes of sulfur compounds and of the individual compounds in petroleum and its products is difficult. The sulfur compounds originally in crude oil are complex, relatively unstable, and break down during refining processes to give simpler compounds. The more obvious of these compounds are hydrogen sulfide (H_2S) with the odor of rotten eggs and mercaptans (R-SH) which have an alliaceous odor. Fortunately both hydrogen sulfide and mercaptans are easily removed from natural gas and petroleum product streams. They are also actually and potentially the most valuable as petrochemicals.

The other types of sulfur compounds in petroleum are

R-S-R
Sulfides

R-SS-R
Disulfides

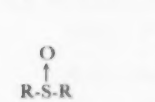


Thiophenes

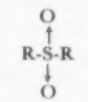
$R\text{-}S_n\text{-}R$
Polysulfides

These compounds are difficult to extract from petroleum, but most of them can be synthesized from olefins or diolefins by reactions with hydrogen sulfide or sulfur. Because of this they are readily available in large quantities at a low cost.

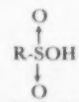
The following oxygen containing sulfur compounds do not occur in petroleum but are obtained from hydrocarbons by simple reactions (except the sulfoxides).



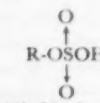
Sulfoxides



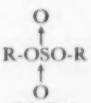
Sulfones



Sulfonic acids



Alkyl hydrogen sulfates



Dialkyl sulfates

The alkyl hydrogen sulfates and dialkyl sulfates are intermediates in the preparation of alcohols from olefins.

$$CH_2CH = CH_2 + H_2SO_4 \rightarrow CH_3CHCH_3 \quad (OSO_3H)$$

$$CH_3CHCH_3 + H_2O \rightarrow CH_3CHOHCH_3 + H_2SO_4 \quad (OSO_3H)$$

group of the periodic table; consequently one would expect similarities in the behavior of their derivatives. The differences which occur can be attributed to the fact that the sulfur atom has one more electron layer than the oxygen atom and that the sulfur atom may in some cases expand its valence shell beyond eight electrons. The sulfur atom also has a smaller effective nuclear charge and a greater electron mobility.

The greater atomic weight of the sulfur atom causes sulfur compounds to have a higher molecular weight than their oxygen analogs. This accounts for some of the differences in physical properties. The differences in the reactions of the aliphatic and aromatic derivatives are less with sulfur compounds than with oxygen compounds.

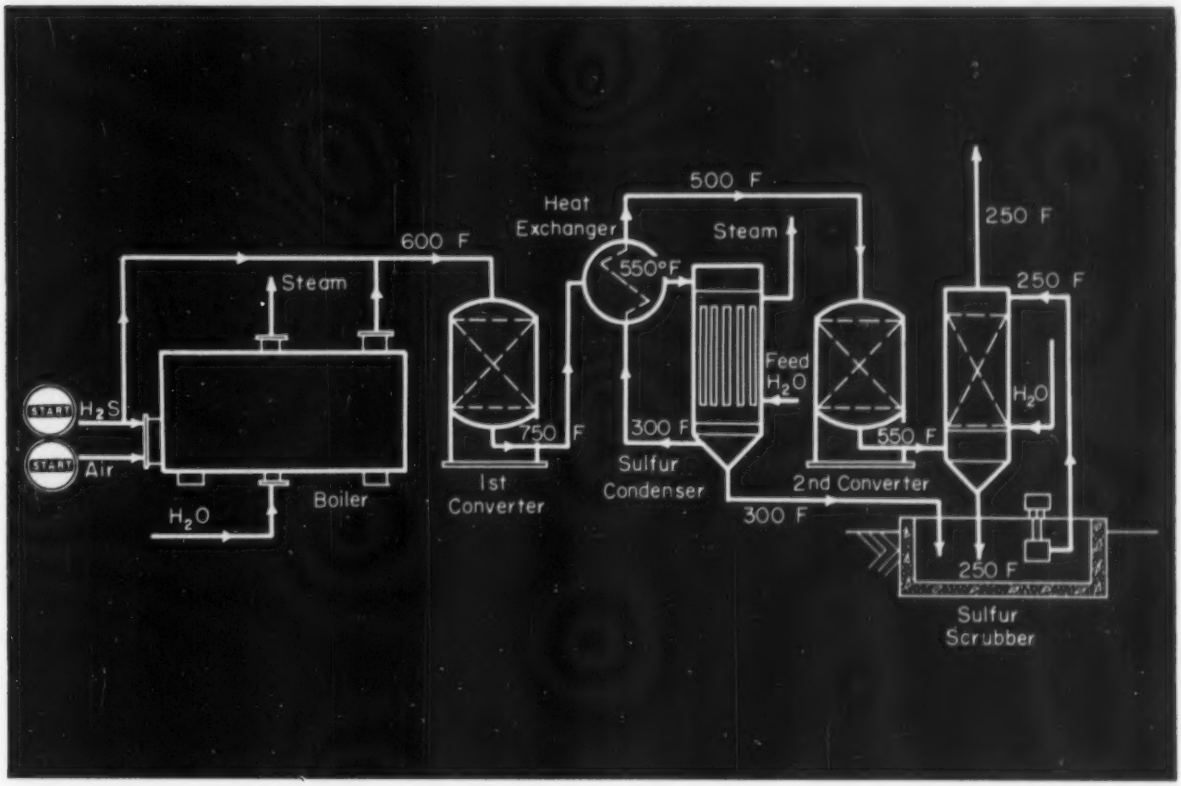
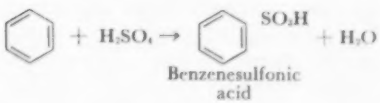


FIGURE 1—Sulfur from hydrogen sulfide.

Sulfonic acids are prepared by the reaction between an aromatic hydrocarbon and sulfuric acid.



Benzenesulfonic acid

Sulfonic acids are very important in the preparation of dyes, detergents, pharmaceuticals and phenols.

The sulfuric acid derived compounds are the most important of the sulfur containing petrochemicals and as such have been frequently described. For this reason they will not be considered further in this article.

Oxygen and sulfur are in the same

Hydrogen Sulfide—A substantial amount of the annual production of hydrogen sulfide comes from natural gas and petroleum streams from which it is separated by standard extraction and separation processes. The most important use of this hydrogen sulfide is its oxidation to sulfur, a process given impetus by the postwar shortage of sulfuric acid. This sulfur plays a minor but important role in the nation's sulfur supply.

The process used to obtain sulfur from hydrogen sulfide is based on the highly exothermic reaction

$$2H_2S + O_2 \rightarrow 2S + 2H_2O$$

The reaction is usually carried out in two steps to permit a better temperature control.

1. $2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$
2. $2H_2S + SO_2 \rightarrow 3S + 2H_2O$

Figure 1 shows a typical two-stage operation utilizing a feed gas containing about 90 percent hydrogen sulfide. Approximately one-third of the hydrogen sulfide is burned to sulfur

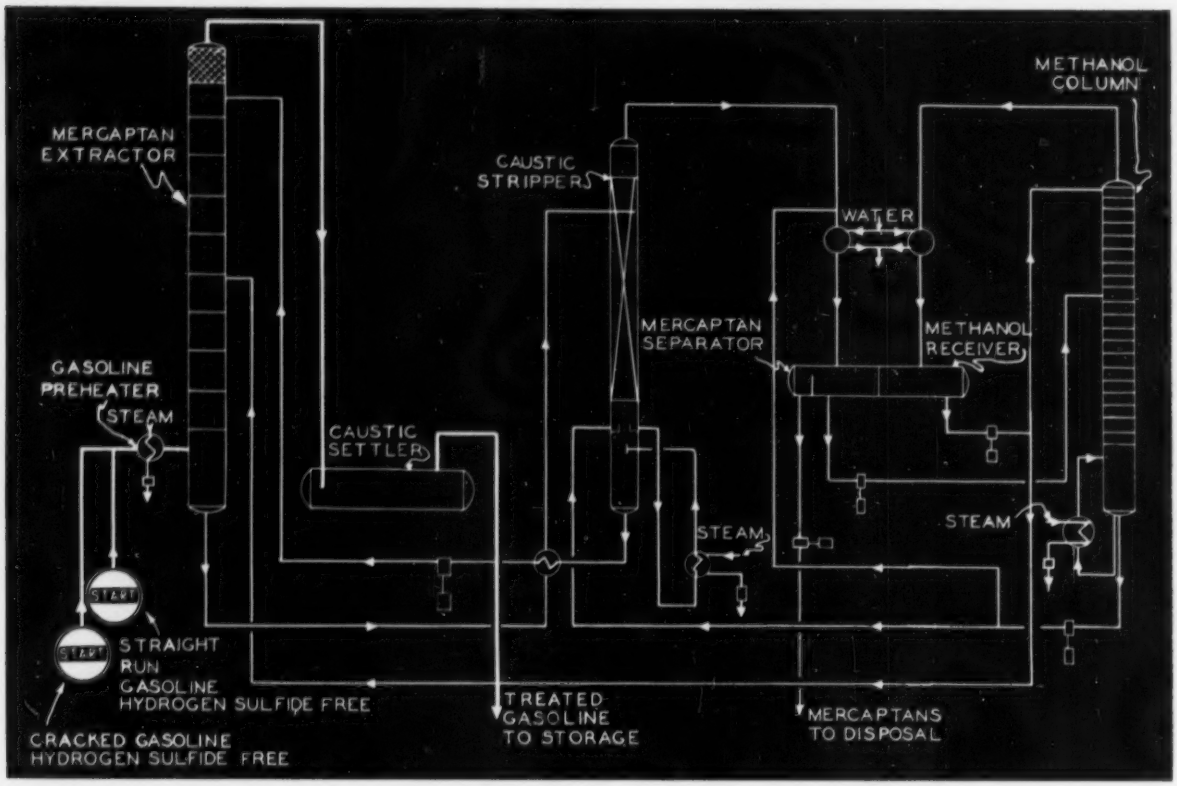


FIGURE 2—Mercapsol treating.

dioxide in the combustion chamber. Seventy to 80 percent of the sulfur is produced in the first converter and the balance in the second converter to give an over-all yield of at least 90 percent. Activated bauxite is used as a catalyst and it has an indefinite life, subject only to mechanical failure. This process produces a high quality sulfur.

Hydrogen sulfide is of interest to the organic chemist because it will add to carbon-carbon double bonds to give mercaptans. It will also react with alcohols to give mercaptans or sulfides depending upon the conditions employed.

Hydrogen sulfide is a toxic gas and should be given the same respect as that given to hydrogen cyanide.

Mercaptans—Mercaptans (thiols) are formed during the refining of petroleum by the breakdown of more complex sulfur compounds. Although they are not present in large amounts, the tremendous quantities of petroleum refined make them the most readily available of the organic sulfur compounds. It is estimated that this source alone could furnish hundreds of tons of mercaptans daily. The mixture of mercaptans thus obtained (Figure 2) consists mostly of ethyl mercaptan (CH_3CH_2SH) with lesser but still considerable quantities of methyl mercaptan (CH_3SH) and higher molecular weight mercaptans. In addition to this source of mercaptans, they can be synthesized from olefins, alcohols and alkyl halides.

The offensive odor of mercaptans is probably their most distinguishing characteristic. Methyl mercaptan is partly responsible for the odor of feces and that of urine after asparagus has been eaten. It has been estimated that ethyl mercaptan can be detected in air at a concentration as low as one part in fifty billion. Butyl mercaptan gives an agitated skunk its offensive advantage. The unpleasantness and intensity of mercaptan odors decrease with increase in molecular weights. Advantage is taken of the odor of mercaptans in their use as warning agents in gases.

Mercaptans are toxic and care should be taken in handling them. The symptoms of mercaptan poisoning are similar to those of one being in love: drooping of eyelids, increased sensitivity of the eyes to light, giddiness, headache, or severe irritations of the skin.

The solubility of mercaptans in water is usually less than the corresponding alcohols. Ethyl mercaptan is soluble to the extent of 1.5 grams in 100 grams of water. They have normal solubility in organic solvents.

The boiling points of mercaptans are lower than the corresponding alcohols having less than seven carbon atoms and higher than the corresponding alcohols having more than seven carbon atoms. Mercaptans have less tendency than alcohols to associate, and this accounts for the lower boiling point of the first members of the homologous series.

Synthesis and Utilization. In spite

of the several disadvantages associated with the utilization of mercaptans, some progress has been made. They can be synthesized by several methods having industrial possibilities. The reaction between an alkyl halide and sodium hydrogen sulfide has been used for a number of years by Sharples Chemical Division, Pennsylvania Salt Mfg., Co., for the production of amyl mercaptan (Pentalarm).

$$C_5H_{11}Cl + NaSH \rightarrow C_5H_{11}SH + NaCl$$

Sharples also produces ethyl mercaptan, C_3-C_4 mercaptans, and *tert*-dodecyl mercaptan.

The Union Oil Company has studied the sodium hydrogen sulfide reaction in respect to the preparation of methyl mercaptan (methanethiol) from methyl chloride.

$$CH_3Cl + NaSH \xrightarrow{H_2S} CH_3SH + NaCl$$

Conversions of methyl chloride to methyl mercaptan of 87 mole percent per pass and yields of 98 percent were obtained at 70° and 175 pounds per square inch gage with a contact time of 11 minutes. The principal side reaction with this method of synthesis is the formation of dimethyl sulfide and an excess of hydrogen sulfide was used to suppress it.

The demand for methyl mercaptan has exceeded the supply from petroleum product streams, and American Oil Company has recently completed a methyl mercaptan synthesis unit at Texas City with a 5 million pound per year capacity. Their process involves the high temperature reaction between methyl alcohol and hydrogen sulfide.

$$CH_3OH + H_2S \rightarrow CH_3SH + H_2O$$

The reaction is carried out under pressure and presumably a catalyst is used.

The principal use of methyl mercaptan is the synthesis of methionine from acrolein. Methionine is a feed supplement for poultry. Methyl mercaptan is also used in the synthesis of jet fuel additives and fungicides.

Ethyl mercaptan is used as an odorant for natural gas and other odorless, toxic gases and in the synthesis of Sulfonal. Ethyl mercaptan is obtained as a byproduct of refining (Union Oil Company, Standard Oil of California). At present this source can supply the yearly demand of about 2 million pounds. The supply of ethyl mercaptan can be increased from refinery streams and by American Oil. Their methyl mercaptan unit is designed to produce both ethyl mercaptan and propyl mercaptan if a market for them develops.

Olefins will react with hydrogen sulfide by addition to form mercaptans (Phillips Petroleum Company).

$$R\text{-}CH=CH_2 + H_2S \rightarrow R\text{-}CHSH\text{-}CH_3$$

This method has been used to produce various tertiary mercaptans (*tert*-butyl mercaptan) but is not of great importance at the present time. Dialkyl sulfides are the principal byproducts.

High molecular weight mercaptans are used to a small extent in the production of detergents. These mercaptans are not usually otbained from petroleum.

Sulfides—Dialkyl sulfides (thioethers, thia compounds) occur in various places in nature such as oil of garlic (diallyl sulfide), soy sauce (γ-hydroxypropyl methyl sulfide) and petroleum. They have disagreeable odors, but they are not so bad as the mercaptans. They are nonassociated and their boiling points are about the same as those of hydrocarbons, ethers, and mercaptans of the same molecular weight. They are, in general, of little importance in petrochemistry.

Synthesis. Sulfides may be synthesized by a reaction analogous to the Williamson synthesis.

$$RSNa + RX \rightarrow R\text{-}S\text{-}R + NaX$$

The reaction takes place readily with ethyl alcohol as the solvent.

The reaction between a mercaptan and an olefin accounts for the formation of sulfides as byproducts when mercaptans are synthesized by the reaction between an olefin and hydrogen sulfide.

$$RCH=CH_2 + RSH \rightarrow RCH_2CH_2\text{-}S\text{-}R$$

The addition is sensitive to the peroxide effect and will not follow Markownikoff's rule unless special precautions are taken.

Dimethyl sulfide (thiapropane) is reported to be produced by the reaction between methanol and hydrogen sulfide

$$2CH_3OH + H_2S \rightarrow CH_3\text{-}S\text{-}CH_3 + 2H_2O$$

Dimethyl sulfide has recently received considerable publicity with the announcement by Crown Zellerbach of a 2 million pound per year pilot plant for its production. The dimethyl sulfide will be obtained from "black liquor" (spent kraft digester liquor) with methyl mercaptan as a potential byproduct. Sharples is already in the market with an industrially pure synthetic product, and Hercules offers a technical grade (63 percent dimethyl sulfide). The only current use of dimethyl sulfide is as an odorant or counter-odorant in industrial gases. Its future is in organic synthesis with one of the most important reactions being its oxidation to dimethyl sulfoxide (Stepan Chemical Company).

Dimethyl sulfoxide, $CH_3\text{-}SO\text{-}CH_3$, DMSO, is high boiling (189°), water white and nearly odorless. It is being proposed as an antifreeze, paint remover, reaction medium, solvent for acetylene and synthetic fibers, a selective solvent for petrochemicals and for use in fatty acid purification. The possibilities in synthesis are comparatively few.

Mustard gas (β,β′-dichloroethyl sulfide) is formed by the reaction be-

TABLE 1—Physical Properties of Various Sulfur Compounds*

COMPOUND	Formula	Freezing Point °C	Boiling Point °C	Density g/ml. 25°	Refractive Index 25° D
Mercaptans:					
Methyl	CH_3SH	—123	5.96		
Ethyl	CH_3CH_2SH	—147.9	35.0	0.8332	1.4278
n-Propyl	$CH_3CH_2CH_2SH$	—113.1	67.8	.8362	1.4353
Isopropyl	$CH_3CHSHCH_3$	—130.5	52.6	.8086	1.4225
n-Butyl	$CH_3(CH_2)_2CH_2SH$	—115.7	98.4	.8368	1.4403
tert-Butyl	$(CH_3)_3CSH$	1.1	64.2	.7947	1.4201
n-Pentyl	$CH_3(CH_2)_3CH_2SH$	— 75.7	126.5	.8376	1.4444
Sulfides:					
Dimethyl	CH_3SCH_3	— 98.2	37.4	.8423	1.4323
Diethyl	$CH_3CH_2SCH_2CH_3$	—103.9	92.1	.8312	1.4402
Disulfides:					
Dimethyl	CH_3SSCH_3	— 84.7	109.6	1.0569	1.5230
Diethyl	$CH_3CH_2SSCH_2CH_3$	—101.5	152.6	0.9882	1.5047
Thiophenes:					
Thiophene		— 38.2	84.1	1.0589	1.5257

* Data from API Research Project 48.

tween ethylene and sulfur chloride at 50-60°.

$$2CH=CH_2 + S_2Cl_2 \rightarrow ClCH_2CH_2\text{-}S\text{-}CH_2CH_2Cl + S$$

Mustard gas is a strong vesicant which has been used as a war gas.

Thiophene and its derivatives are found in petroleum fractions, but they are not obtained commercially from this source. Index Chemicals Company, a subsidiary of Pennsylvania Salt Manufacturing Company, is reported to be manufacturing thiophene under Socony-Mobil Oil Company, Inc., patents. The process is a high temperature reaction between butane and sulfur.

$$CH_3CH_2CH_2CH_3 + 4S \xrightarrow{600°} \begin{matrix} HC{-}{-}CH \\ \| \quad \| \\ HC \quad CH \\ \quad \diagdown S \diagup \end{matrix} + 3H_2S$$

Sulfur is a dehydrogenating agent and olefins and diolefins are produced along with the thiophene with the ratio depending on the recycle stream. With a 95 *n*-butane charge stock an 80 percent conversion is obtained and a product ratio of 35 percent thiophene, 35 percent butadiene and 30 percent *n*-butene. Recycling of the unreacted butane and butene will give a 75 percent conversion to an equal weight of thiophene and butadiene. When butane, butene and butadiene are recycled, a 50 percent conversion to thiophene is obtained. The main byproduct other than hydrogen sulfide is a complex tar of high sulfur content. The sulfur in this tar can be recovered by burning it with enough hydrogen sulfide to give the following reaction.

$$2H_2S + SO_2 \rightarrow 3S + 2H_2O$$

Thiophene is used in making dyes and pharmaceuticals and has a future in plastics, resins, agricultural and photographic chemicals.

Disulfides—Disulfides occur to a small extent in petroleum fractions and are present in various exotic places such as onions, oil of garlic and oil of asafetida. Their odors are not as objectionable as those of mercaptans although they still are not socially acceptable. Disulfides are vesicants which produce symptoms similar to those of poison ivy with individual responses varying greatly.

Disulfides are not petrochemicals but are produced in quantity during Doctor sweetening of gasoline. The reaction is one of oxidation of mercaptans to disulfides by lead plumbite.

1. $PbO + 2NaOH \rightarrow Na_2PbO_2 + H_2O$
2. $2R\text{-}SH + Na_2PbO_2 \rightarrow RS\text{-}Pb\text{-}SR + 2NaOH$

Some of the mercaptans are changed to water soluble thioplumbite (R-S-PbONa). The lead mercaptides remain dissolved in the hydrocarbon phase where they are treated with sulfur to get the lead out.

$$RS\text{-}Pb\text{-}SR + S \rightarrow R\text{-}SS\text{-}R + PbS$$

The lead sulfide precipitates and the disulfides remain in solution. Basically Doctor sweetening merely changes mercaptans to less objectionable disulfides; the total sulfur content of the hydrocarbon fraction is not appreciably changed.

Sulfones—Sulfones are readily obtained by the reaction between olefins and sulfur dioxide. The product is polymeric with an olefin-SO_2 ratio of 1 to 1.

$$nR\text{-}CH=CH\text{-}R + nSO_2 \rightarrow \left[\begin{matrix} R & R & & R & R & \\ | & | & & | & | & \\ -C & -C & -SO_2- & C & -C & -SO_2- \\ | & | & & | & | & \\ H & H & & H & H & \end{matrix} \right]_n$$

One interesting characteristic of this type of reaction is the maximum temperature (ceiling temperature) above which copolymerization will not take place. This temperature is usually below 100°. The reaction runs smoothly for 1-olefins ($RCH=CH_2$) and their derivatives and a few 2-olefins. Nearly all of the usual polymerization catalysts seem effective for this polymerization. The polysulfones are white, amorphous powders with relatively high melting points. They decompose at high temperatures to yield the original olefin or olefin derivative and sulfur dioxide.

The sulfones formed from diolefins and sulfur dioxide are in sharp contrast to those formed with monoolefins, for nearly all dienes form crystalline cyclic monosulfones. The sulfone formation is a reversible reaction, and the diene and sulfur dioxide can be regenerated at higher temperatures and atmospheric pressure.

$$CH_2=CHCH=CH_2 + SO_2 \rightarrow \begin{matrix} HC=CH \\ | \quad | \\ H_2C \quad CH_2 \\ \quad \diagdown SO_2 \diagup \end{matrix}$$

The melting point and decomposition temperature of several dienes are given in Table 2.

The formation and subsequent decomposition of cyclic sulfones have received attention as a means of diene separation and purification. The diene is obtained in high purity, but the process is comparatively expensive. A more recent method of cyclic sulfone utilization is their hydrogenation to saturated cyclic sulfones (Sulfolanes, Shell Chemical Corporation). These tetramethylene sulfones are stable below 240°, noncorrosive, chemically inert and possess very high selective solvent properties for aromatics.

TABLE 2—Cyclic Sulfones

DIENE		SULFONE	
NAME	Formula	Melting Point °C.	Decomposition Temperature °C.
1,3-Butadiene	$CH_2=CHCH=CH_2$	65	125
trans-Piperylene*	$CH_3CH=CHCH=CH_2$	oil	100
Isoprene	$CH_2=C(CH_3)CH=CH_2$	63	125
1,3-Dimethylbutadiene	$CH_3CH=CHC(CH_3)=CH_2$	40	100
2,3-Dimethylbutadiene	$CH_2=C(CH_3)C(CH_3)=CH_2$	135	140

* *cis*-Piperylene forms the same cyclic sulfone which on decomposition yields *trans*-piperylene.

The whole area of sulfur petrochemicals presents an interesting and potentially fruitful field for exploration. Developments may be in the direction of utilization of sulfur compounds from product streams (hydrogen sulfide, mercaptans) or in synthesis of sulfur containing compounds from various hydrocarbons, etc., (mercaptans, sulfides, thiophenes, sulfones). At present only superficial progress has been made, with separation and synthesis far ahead of utilization research. ##

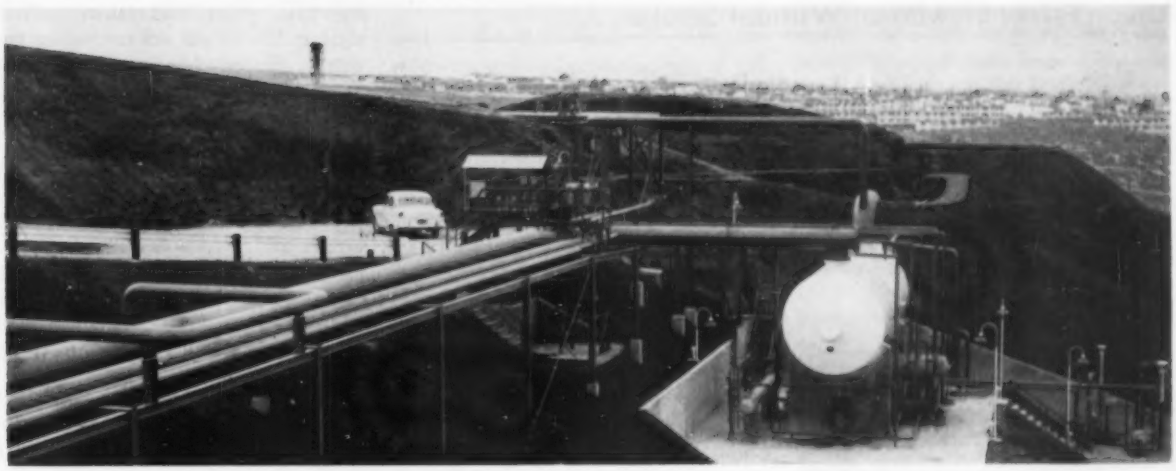


FIGURE 1—Over-all layout of the equipment. Note the flare stack in the left background and the flare pit in the right background. Knockout drum, drain pots, slops cooler and pumps are in the right foreground.

Union Flares Blowdown Without Smoke

This new system automatically eliminates smoke. Controlled burning with a smokeless flare stopped Oleum Refinery's smoke problem.

J. R. Hannaman, Union Oil Company of California, Los Angeles
A. J. Etingen, Bechtel Corporation, Los Angeles

A MODERN RELIEF and blowdown flare system has been installed at the Oleum Refinery of Union Oil Company of California. This refinery is located in Contra Costa County on the eastern shore of the Carquinez Straits north of San Francisco Bay.

The term "relief and blowdown facilities" is used here to describe a complete relief and blowdown system which includes: a smokeless flare stack, a flare pit, knockout drums, a slops pumpout system, seal drum, and all the instrumentation and alarm systems pertaining to this equipment. These relief and blowdown facilities were designed to serve a group of newly constructed plants. These plants are a 14,000 barrel per day platformer, unifiner, unisol and sulfur plants.

The plants are located on Tormey Hill east of U. S. Highway 40 at an elevation of 110 feet above sea level. They occupy a newly developed area and the nearest existing plant in the refinery is 1500 feet away.

A relief and blowdown system was designed to serve only the new plants, consisting of a short smokeless stack and a ground flare pit. After considerable study, this equipment was located at a minimum distance of 400 feet from any operating plant or storage tank. The elevation of the knockout drum and associated equipment was established as 70 feet (the plants' elevation being 110 feet) and the elevation of the stack and flare pit as 97 feet and 89 feet, respectively.

The system is shown schematically in Figure 2. All the relief headers from the process units combine into a common 24-inch header which deposits the hydrocarbon gases and liquids into a 10-foot x 30-foot knockout drum. The relief line from the butane storage spheres bypasses the knockout drum. Liquids which accumulate in the knockout drum are pumped from the drain pot through a slops cooler to a 15,000-barrel floating roof tank.

The hydrocarbon gases can leave the knockout drum in two ways. Blows smaller than an equivalent flow of 60,000 pounds per hour of propane flow through a 10-inch line to the smokeless flare stack and are ignited by constantly burning pilots at the tip of the stack. Steam is proportioned to the stack for smokeless burning of the hydrocarbon gases through a control valve set by a pressure indicating controller which is actuated by back pressure of the gases to the stack.

When the blow is of such magnitude that the back pressure on the

stack line exceeds 48 inches of water, the water seal will blow and the gases are dumped to the flare pit through a 30-inch line where they are ignited by constant burning pilots located on the outlet of the pit pipe.

Hydrocarbons when dumped to the pit will burn with smoke, as equipment was not provided nor considered necessary at this outlet to enable smokeless burning.

The maximum quantities for which the system was designed are summarized in Table 1.

TABLE 1

PLANT	Max. Blow Lbs./ Hr.	Molecular Wt.	Temp. °F.	Pressure Plot Limits
Platformer-Unifiner	425,000	21.4	257	27.0
Unisol Plant	95,000	58	205	12.7
Sulfur Plant	10,730	34	258	10.0
Butane Spheres	14,000	58	40	6.5

These design conditions are based either on fire blowdown load or cooling water failure load, dependent on which is controlling for the unit involved. All effort was made within design of the several units to reduce their potential blowdown loads primarily because of space limitations for safe location of the ground flare and secondarily because of economics of required header piping size.

As an example, the platformer-unifiner relief load, which was the controlling design condition for the system, was based on cooling water failure at these units. These units are combined and served by a central cooling tower.

Initial calculations indicated that the large relief load resulting from total failure of the entire cooling system precluded safe installation of a ground flare with the real estate available and also would require extremely large headers.

To reduce this requirement the basin of the cooling tower was divided into two sections with separate water supply and return headers for each section. This minimized the possibility of disrupting the entire cooling water system and cut the design relief load essentially in half to the quantity shown in Table 1.

Balanced area type relief valves were used wherever feasible within the units to increase available plot limit relief pressure in order to reduce the

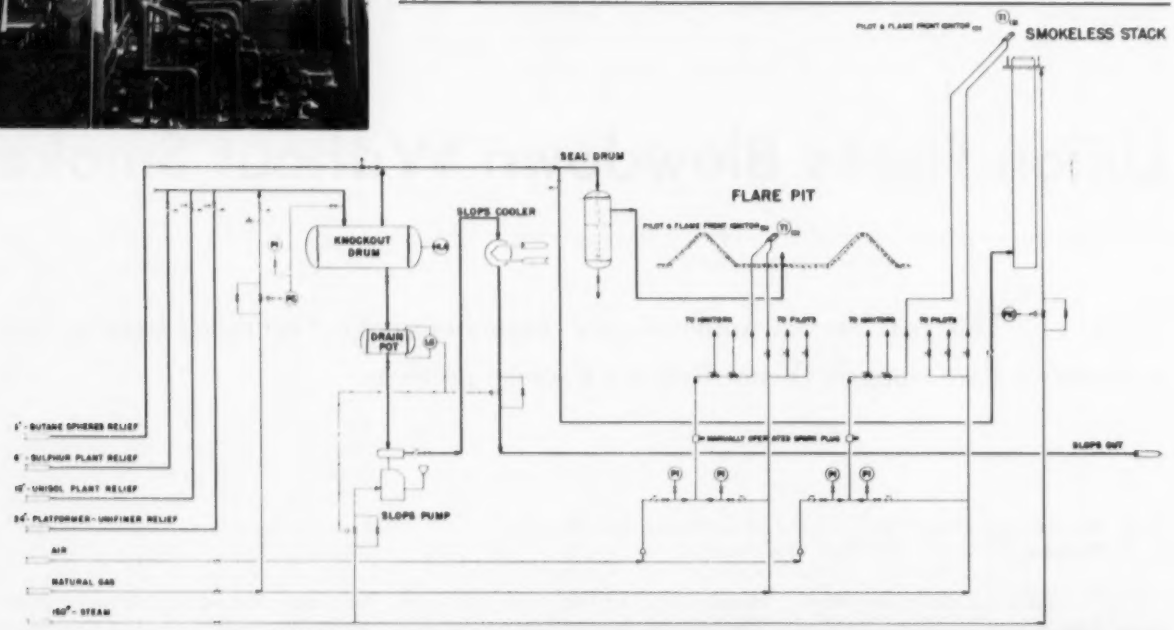
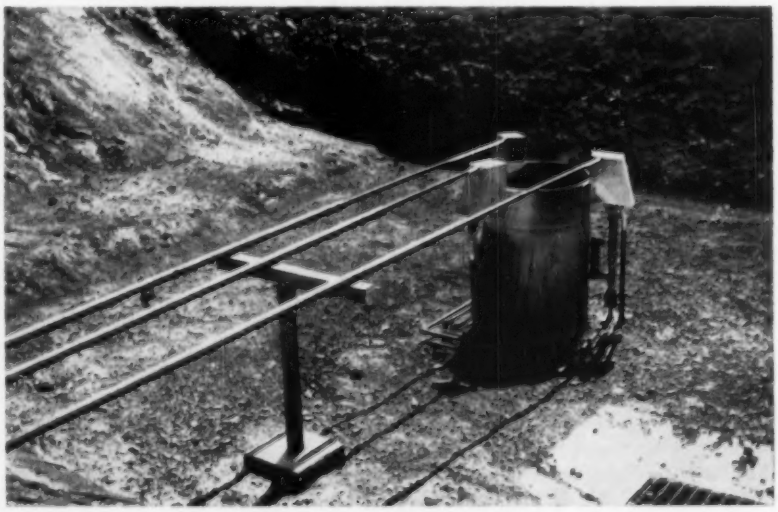


FIGURE 2—Flow diagram of the facilities. Flare pit on lower right and knockout drum and water seal on the upper left.



size of headers to the flare. Headers were sized on the basis of the design gas flow rates not to exceed 80 percent of sonic velocity.

It was assumed that the smokeless flare stack design capacity, 60,000 pounds per hour of propane, was sufficient to take care of operational irregularities and leaky relief valves. In the event of a heavy relief, the water seal in the seal drum will blow out and the hydrocarbons will burn in the ground flare pit with smoke. Reliefs of this size are rare and their occurrence is the result of a major emergency with smoke emission being inevitable.

The relief line from the butane storage spheres bypasses the knockout drum. This was done to eliminate any possibility of pumping butane into the slops tank, where the butane might flash and expose the tank to excessive pressure. The temperature of the slops was estimated at 300 F. It is reduced to 100 F by pumping the liquid through a shell and tube cooler.

A turbine was selected to drive the slops pump because a failure of electrical power can cause some of the units to blow, requiring the services of the pump. In order to eliminate the possibility of an accumulation of an explosive mixture within the equipment and piping, the entire system is blanked with natural gas, maintaining a pressure of one inch of water at the knockout drum.

The smokeless burner is shown in Figure 3. This unit is well known in the industry and will be discussed here only briefly, stressing the newly developed features. The stack is 14

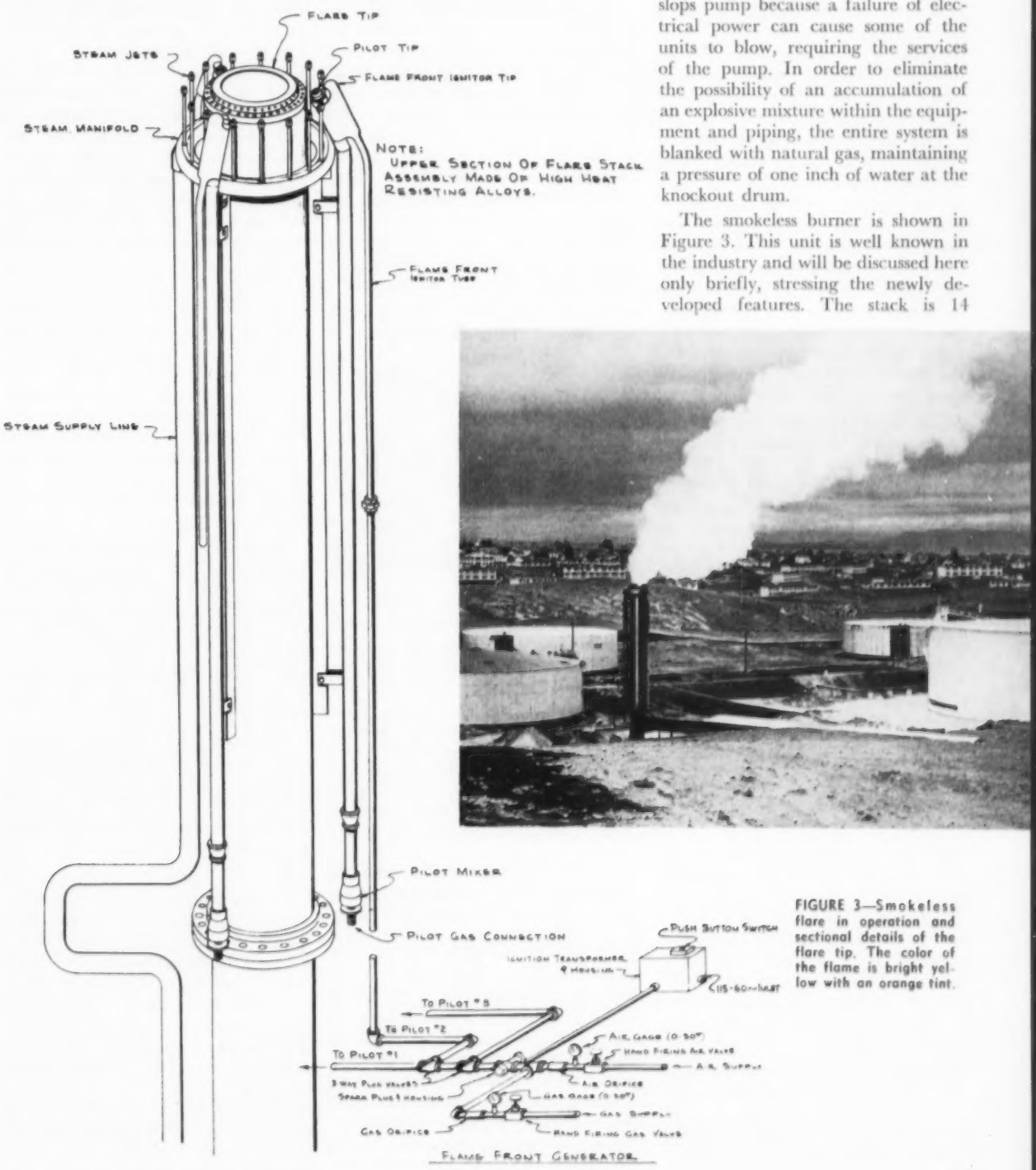


FIGURE 3—Smokeless flare in operation and sectional details of the flare tip. The color of the flame is bright yellow with an orange tint.

inches in diameter and 15 feet in height of which the upper 8 feet are a high chrome alloy. The smoke is suppressed by 27 steam jets set in an alloy ring manifold. The steam jet tips are set alternately 30 and 45 degrees from the vertical, thus creating two steam cones to reduce back pressure due to steam entering the stack, and to improve aspiration of air into the flame zone. The steam consumption of the burner, at peak blow, is 12,000 pounds per hour (0.2 pounds of steam per pound of gas).

The burner is equipped with a "constant pilot ignitor hood." This hood is hollow and encloses the upper portion of the two-inch pilot supply line. Weep holes are drilled through the supply line about 10 inches below the pilot to allow a portion of the pilot gas-air mixture to bleed into the annular space between the hood and the line. This gas flowing upward toward the tip burns separately from the pilot to hold the ignition for the pilot flame.

The flame front pipe enters at the bottom of the hood to first kindle the bled gas and then the pilot tip proper (see Figure 3). The flame front generator is located about 150 feet from the stack to permit remote ignition in the event of pilot failure. The flare pit also is equipped with three pilots and ignitors and also these pilots, in case of failure, can be remotely ignited by a flame front generator.

An alarm system was installed to warn the operators (in the adjacent plants) that a pilot is out in either the flare stack or the flare pit. This system consists of Chromel-Alumel thermocouples installed directly in the flame of the pilots, and connected to a six-point temperature recorder, equipped with an alarm switch.

In case of failure of one of the pilots the drop of temperature at this pilot is recorded on the temperature recorder, which in turn actuates a switch which turns on both a horn and a red light. By inspection of the chart, the operator identifies the extinguished pilot and re-ignites it with the flame front generator.

The knockout drum (Figure 2) is equipped with a high level alarm to warn of any excessive accumulation of liquid in the system. This alarm is relayed to the same horn and red light serving the pilot failure alarm.

The operator can readily identify which equipment requires attention since high level in the knockout drum causes sustained operation of the horn and light while the pilot alarm is intermittent, signaling only when the recorder is reading the temperature of the extinguished pilot.

In order to obtain a smokeless flame at the flare stack, steam must be injected into the flame zone. The quantity of steam required is proportional to both the rate and composition of the hydrocarbon gases flowing to the stack. To proportion the proper quantity of steam to the flame for each blow is a difficult task due to variation in composition of the relieved gases.

For this reason the instrumentation to control proportionate quantities of steam is limited to pressure control; that is, the steam flow is controlled by the pressure in the blowdown header to the stack. A pressure controller with a range of 0-20 inches of water was installed actuating a 2½-inch quick opening control valve in the steam line.

A quick opening valve was selected because its characteristic flow curve closely resembles the characteristics of the stack discharge. Such a valve also responds with adequate steam for reliefs of small magnitude.

Referring to Figure 2, note that the relief headers from the various plants are valved just before the common 24-inch header discharging into the knockout drum. In the event that one of the units is down, its relief header valve is closed and the blowdown system continues to operate while any necessary maintenance is performed on the isolated line.

These block valves were installed in an upside down position to eliminate the remote possibility of the disc of the valve dropping into the header and blocking it (when the valve is in open position) due to corrosion of the tee head connection of the stem and disc. The header to the stack is so valved that the stack can be shut down for repairs and the system will relieve through the flare pit during such a repair period.

The drain pot just below the knockout drum is an auxiliary knockout drum. It will carry, most of the time, the liquid vapor interface where most of the corrosion will occur. It is so valved that it can easily be removed and readily replaced by a duplicate drum without disrupting the operation of the entire system.

The relief and blowdown facilities have been in operation since mid-January, 1955, and although some initial adjustments had to be made, it can be said that operation has been very satisfactory.

Gas rates exceeding the capacity of the smokeless stack have been relieved through the system several times causing the water seal to blow and putting the pit into operation in a very satisfactory manner. In one case the blowing relief valve was known and the relief quantity was established as 240,000 pounds per hour of material of molecular weight of 18.4. Operation of the system at these rates demonstrated that the pit was located at a safe distance from the tanks and operating units. ##

Meet the Authors

Hannaman

Etingen

J. R. HANNAMAN, a resident engineer for Union Oil Company of California, was also project manager for the Manufacturing department's Head Office Engineering and Construction division, handling installation of these facilities at Oleum. The project was part of Union's recent $40-million refinery-expansion program. Hannaman is a 1942 graduate of the University of California.

A. J. ETINGEN joined Bechtel Corporation in 1942, following his graduation from the University of California with a degree in civil engineering. Until 1949 he worked in the field as an engineer on petroleum-refinery and chemical-plant projects, receiving an assignment the following year as assistant to the construction manager. Since 1951, he has been a project engineer in the company's Refinery Engineering division. Born in Palestine, Etingen now is a registered mechanical engineer in California.

Get the maximum out of . . .

Licensing Your Process

Robert S. Aries
R. S. Aries & Associates
New York City

WHILE THE petroleum industry has always adhered to the principle of licensing and purchasing "know-how," the chemical industry did comparatively little about it until World War II. Since then, many processes have been purchased from other companies, engineers and consultants. Foreign companies also have figured in such licensing, both as buyers and sellers.

Such diverse products as aluminum, resins, and urea have been licensed from abroad. Foreign processes, however are used more fully when the engineering is done in the U. S. (as in the case of urea). Contrary to this American requirement, most underdeveloped countries prefer "packaged" plants made in the country of origin, as they are not equipped to provide superior chemical engineering.

The licensing agreement should be tailor made to the specific conditions. Some points to be considered have been indicated by the Foreign Operations Administration and since they have been found very useful, the list follows:

1. Do you wish to request a cash payment for any process, economic, market or financial information required initially? This payment might include subsequent information and privileges to ask questions. Some make it a point to always insist on a small payment for a preliminary report in order to separate the serious inquiries from information seekers.

2. Do you wish to receive a percentage of the net invoice value of any chemical sold?

3. Do you want to receive an equivalent percentage of the invoice value of any chemicals used internally by the licensee for the manufacture of derived products? Frequently this is charged at cost price.

4. Do you wish the life of the agreement to be the life of the pertinent patents existing or applied for? Do you wish to terminate the agreement if, after a stated period of years from the date of the agreement, the total income derived from the licensee falls below a stated sum in any given years?

5. Do you want the privilege of converting the royalties or other remuneration into stock of the licensee's corporation?

6. If your licensee does a satisfactorily profitable business, do you wish to have an equity in the corporation and receive future royalties in the form of dividends on your stock?

7. Do you wish to make your contract with the licensee on a non-exclusive basis, specifically reserve the right to make similar arrangements, or make it exclusive for a specified number of years and non-exclusive thereafter?

8. Depending upon the product involved, do you wish to have a clause in your contract whereby you are enabled to check the quality of the product produced so that it will conform to adequate standards?

9. Do you wish to reserve the right of inspection in the plant of the licensee (as to methods used, raw materials involved, and/or the finished product)?

10. Do you desire a provision in your contract for inspection by you or some neutral agency of the books of the licensee, to insure the contract is being lived up to?

11. Do you want to retain the right to cancel the contract or use of trade-name if the proper quality is not maintained?

12. Do you wish a clause in the contract to the effect that it is not assignable?

13. Do you desire a clause whereby the licensee agrees that no information concerning secret formulae or processes will be disclosed to a third party?

14. Do you wish to stipulate how long the agreement is to be in effect?

15. Are you willing that the licensee use your trade marks? If so, quality control may become especially important.

16. Are you willing to give the licensee any improvements or inventions made by you subsequent to the date of the contract?

17. Do you wish to have in the contract an obligation on the part of the licensee to give you the benefit of any improvements made by him after the date of the contract?

18. If, at some future time, a part of the agreement is found to be in-

Meet the Author

ROBERT S. ARIES, in addition to heading his own consulting firm, finds time for teaching a graduate course in chemical-engineering economics at Polytechnic Institute of Brooklyn. In his consulting work, carried on in the U. S., Europe and Latin America, Dr. Aries specializes in a combination of engineering and economics, devoting his skills to the analysis of such items as markets and products, processes and investments. He was educated at the University of Minnesota, Brooklyn Polytech and Yale and Columbia universities; he holds three engineering degrees, plus a master's degree in business administration.

valid, do you wish the remainder of the agreement to continue in force?

19. Should some disagreement subsequently arise after signing the agreement, do you wish to specify under what laws the agreement is to be construed?

20. Do you wish to have an arbitration clause? If so, consult the American Arbitration Association, 9 Rockefeller Plaza, New York, N. Y. or the International Chamber of Commerce, 37 Wall Street, New York, N. Y.

21. If, after the signing of the agreement, you enter into other arrangements under generally similar conditions, but giving more favorable terms to the new licensee, do you wish to provide in the agreement that the said licensee will automatically become entitled to those more favorable terms?

22. Do you wish to reserve the right to approve the licensee's advertising and promotion campaign?

23. Do you wish to stipulate that there shall be minimum payments under a royalty or licensing agreement?

Examples of Licensing Operations—In order to study payment conditions and royalty rates, the author's staff has investigated about 50 actual contracts, on which the information is given here.

The question of payment or royalty rates for the use of patented and secret chemical processes and products and for the use of technical "know-how" and information by licensees presents a difficult problem upon which little has been published. Such rates and payments naturally vary greatly. So far, a methodical process for determining rates has never been established and in all probability never will be formulated.

The reasonableness of a royalty or payment involves many complex factors. At best, a good royalty can be defined as a rate which is arrived at from the normal processes of negotiation between a willing licensor and a willing licensee in a free competitive market.

The basis for the payment of a royalty are many. To the licensee, for example, the patented or secret process or product must have some outstanding merit. It must fit into the economy and the market picture, and it must have some features which are unique and superior in some manner to other processes and products of similar nature or of similar use.

The royalty rate must reflect the importance of the process or product to the licensee. In other words, the licensee must recognize the value of the process or product.

On the other hand, the licensor also has his measure of the proper royalty rate or payments. To him, the cost and efforts of development and research expended on the process are very important. He will consider the extent to which his secret or patent can be made useful and will seriously investigate alternate proposals by other potential licensees.

It is his purpose to request a fair share of the benefits which the licensee derives from the use of the process or product. The difference of opinion between the licensor and licensee on the value of the patent or secret are the subjects for negotiations.

To repeat, the determination of a proper royalty rate is complex. For every case, the economic and technical factors surrounding the invention will present a different picture. The reasons for paying for the use of patented or secret information vary from license to license, from process to process, from product to product. The extent of a royalty payment will vary generally with the following factors:

1. The value of the process or product in our competitive economy.

2. The completeness of the process or product; the amount of research which has been expanded to "perfect" the process or product or conversely the amount of research the licensee will have to expend in order to bring the process or product to commercial fruition.

3. Is the license exclusive or non-exclusive to the licensee?

4. Can the licensee assign his rights and issue sub-licensee to other interested parties.

5. The size of the territory in which the license is effective.

6. The length of time the license is effective.

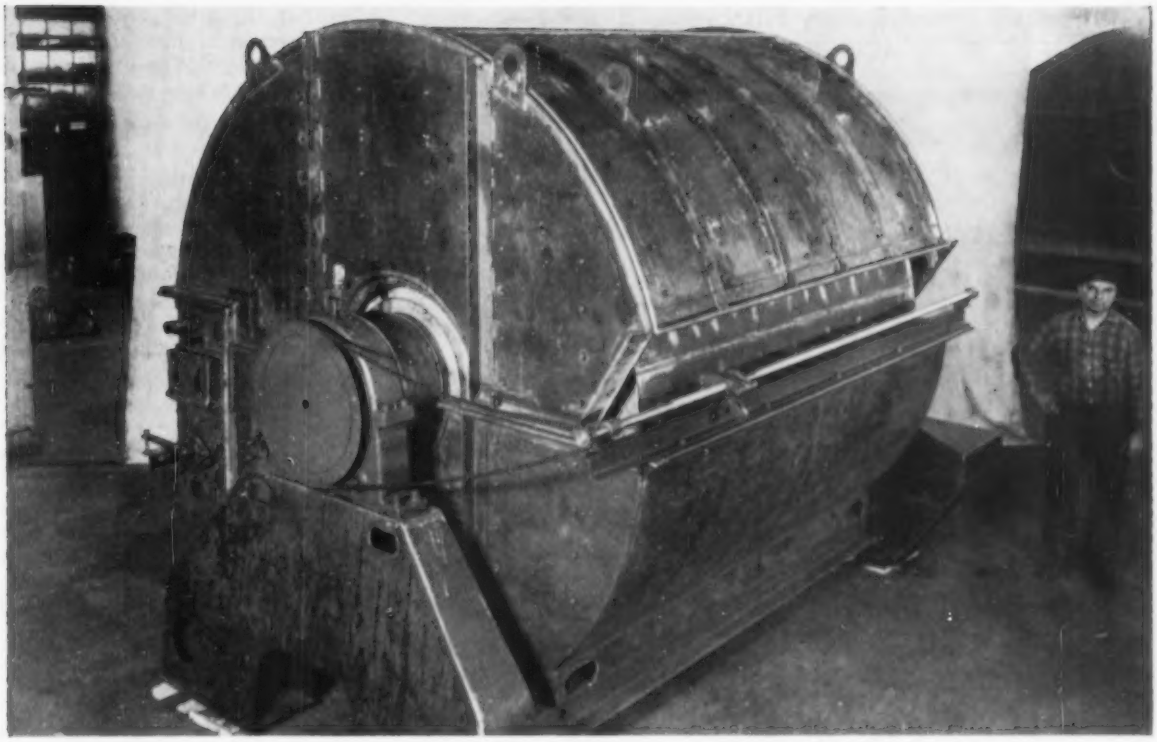
7. If patented, is the patent protection effective or is there a possibility of infringement proceedings?

8. Who receives the right to future inventions and extensions on the process or product?

The first factor alone is very complex. Others undoubtedly will appear in every negotiation. The practices of payments for processes and "know-how" in the chemical process industries are here revealed by the presentation of 33 different license and cross-license agreements. They represent many types of process industries and vary greatly as to form and extent of payments. These are tabulated, together with the subject of the license in Table 1. ##

TABLE 1

SUBJECT	ROYALTY RATE
Percent of Net Profit	
2-Sulphanilyl-Aminopyridine	50% of net profit
Food processing	34%
Percent of Net Sales	
Petroleum Cracking Catalyst	5% of net sales value
Sulfadiazine	5% of net sales value
Crude Rubber	2½% of the amount of the net sales
Polysulfide Synthetic	2½% of the net sales price of the government after the war 5% of the net sales price for private companies.
Percent of Gross Sales	
Drilling Mud Control and Treatment	5% of the gross sales
Petroleum Emulsions	2½% of gross sales
Carriers	5% of the sales price
Styrene	2½% of the actual sales price (captive) 5% of the actual sales price (non-captive)
Percent of Sales with Modification	
Cheese Wrapping Material	10% of net selling price to certain date. 5% of net selling price thereafter.
Sponge Rubber Products	8% of the net sales with a minimum annual royalty return of $4,000.
Rate Per Unit Product	
Polysulfide Synthetic Rubber	$0.00125 per pound made for the government
Styrene	$0.00125 per pound made for the government
Rate Per Unit Raw Material	
Coal Carbonization	1¢ per ton of coal delivered to the retort.
Combination Rates	
Catalytic Petroleum Refining (a) Fluid Catalytic Cracking	5¢ per barrel of fresh feed stock, plus 5¢ per barrel of aviation product, and 3% of the price of any other special liquid products.
(b) Hydro Catalytic Reforming	5½% per barrel fresh feed stock, plus 5¢ per barrel of aviation product, and 3% of the price of any other special liquid products.
Insecticides (DDT) (a) Insecticidal Compositions	5% of the net sales price with a maximum rate. $0.0004 for each percent DDT content up to and including 10%, and $0.000333 for every percent DDT content over 10%.
Rate Per Unit With Modifications	
Polysulfide Synthetic Rubber	$0.0236 per pound, such rate never to be less than 3% of the net selling price.
Lubricating Oils	$0.035 per pound adjusted to the index of wholesale commodity prices, and the chlorine content.



For rotary filters, a process design for continuous operation.

Exact calculation methods for . . .

Continuous Vacuum Rotary Filters

C. D. Holland and J. F. Woodham

ALTHOUGH ROTARY filters have been in operation for many years, a search of the literature shows that an exact mathematical treatment of this process is lacking. Fortunately, the equations describing batch filters are applicable for continuous rotary filters, if the terms in the equations for the former are properly interpreted. In this article the equations describing a rotary filter are derived and compared with the corresponding equations for a batch filter. In addition, expressions more convenient for rotary filter calculations than those in common use are also given. The equations obtained apply for the case of laminar flow of the filtrate through a noncompressible cake. In the derivation of Equations (12), (14), and (15), the variation of the pressure drop with hydrostatic head of the slurry was neglected. However, this variation was considered in the derivation of Equations (18) and (19). In all of the derivations, the centrifugal force was taken to be negligible.

A sketch of the end view of a rotary filter is shown in Figure 1. Beneath the surface of the slurry, the velocity with which the filtrate passes through the cake depends, of course, upon the thickness of the cake at the point of interest. As can be seen from Figure 1, the thickness of the cake at any point depends upon the length of time that the particular point has been submerged beneath the surface of the slurry. Thus the total volumetric flow rate over the entire submerged area is given by

$$F = \int_0^A v dA \qquad (1)$$

All symbols used are defined in the table of notation.

First an equation corresponding to the one used for batch filters will be derived. In order to integrate the right hand side of Equation (1), it is necessary to obtain a relationship between v and A. According to the development of Brown and associates[1] the instantaneous velocity of the filtrate through the cake at any point on the drum is given by

$$v = \frac{k_1 (-\Delta P)}{L} \qquad (2)$$

for the case of laminar flow of the slurry through a noncompressible cake. Also needed is the relationship

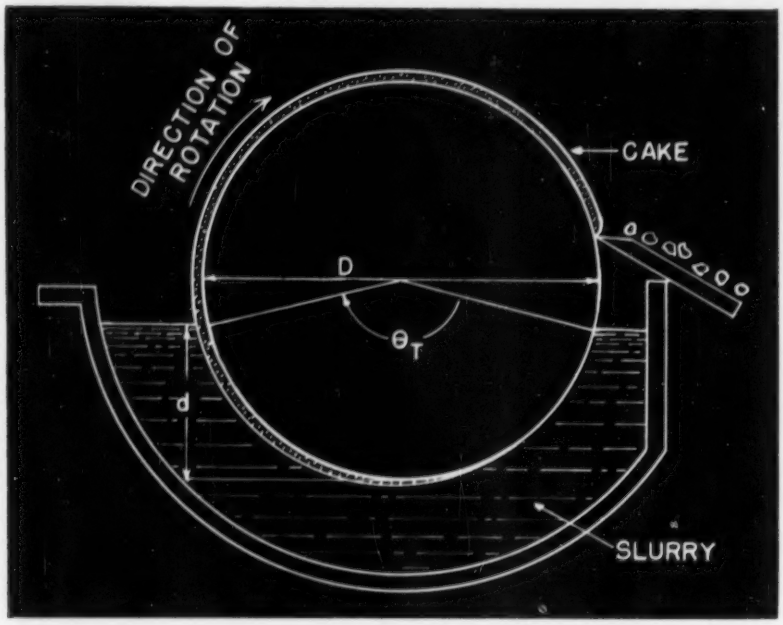


FIGURE 1—Schematic cross-section of a rotary filter.

between the area perpendicular to the direction of flow of the filtrate and the angle θ. Where θ is expressed in radians, it follows that

$$dA = \frac{Dh}{2} d\theta \qquad (3)$$

Taking t as the time required for a point on the periphery of the drum to pass through the angle θ, then

$$d\theta = 2\pi\alpha\, dt \qquad (4)$$

Combining Equations (3) and (4) gives

$$dA = Dh\pi\alpha dt \qquad (5)$$

Substituting Equations (2) and (5) in Equation (1), one obtains

$$F = Dh\pi\alpha k_1 \int_0^t \left(-\Delta P\right) \frac{dt}{L} \qquad (6)$$

L is related to t by returning to Equation (2) and replacing v by its equivalent in terms of L. Since the volume of filtrate (avdt) is formed by depositing from a given slurry a cake of volume (adL) on a suitable filter medium, it follows (by material balance) that

$$v = \frac{(1 - X)\,\rho_s}{r\rho} \frac{dL}{dt} \qquad (7)$$

Replacing v by its equivalent in Equation (2) and integrating at constant pressure drop, one obtains

$$\frac{L^2}{2} = \frac{2k_1^2}{k_2} (-\Delta P_a)\, t \qquad (8)$$

$$\text{where } k_2 = \frac{2k_1 (1 - X)\,\rho_s}{r\rho}$$

Substituting the value of L as given by Equation (8) in Equation (6), it follows that

$$F = \frac{Dh\pi\alpha}{2} \left(\sqrt{k_2 (-\Delta P_a)}\right) \int_0^t \frac{dt}{\sqrt{t}} \qquad (9)$$

Hence,

$$F = Dh\pi\alpha \sqrt{k_2 (-\Delta P_a)\, t} \qquad (10)$$

Now, let $V = Ft$, which is equal to $\frac{F\theta_T}{2\pi\alpha}$. Upon multiplying both sides of Equation (10) by $\theta_T/2\pi\alpha$ and squaring, one obtains

$$V^2 = \left(\frac{D\theta_T h}{2}\right)^2 \left((-\Delta P_a)\, k_2 t\right) \qquad (11)$$

In the above derivation, the resistance of the filter cloth and connecting lines was neglected in the interest of simplicity. If it is included, Equation (1) takes the form

$$F + F_e = \int_0^A v_c\, dA$$

$$\text{where } v_c = \frac{k_1 (-\Delta P_a)}{L + L_e}$$

and the expression corresponding to Equation (11) is as follows

$$(V + V_e)^2 = \left(\frac{D\theta_T h}{2}\right)^2 (-\Delta P_a)\, k_2 (t + t_e) \qquad (12)$$

The corresponding equation for a batch filter press is

$$(\bar{V} + \bar{V}_e)^2 = (\bar{A})^2 (-\Delta P_a)\, k_2 (\bar{t} + \bar{t}_e) \qquad (13)$$

Meet the Authors

Holland

Woodham

C. D. HOLLAND, a member of the graduate chemical-engineering faculty at Texas A&M College, received a B.S. degree in chemical engineering at North Carolina State College in 1943. After time out for service in the Navy and a year with Burlington Mills Corporation, he enrolled at Texas A&M, taking a M.S. degree in chemical engineering in 1949 and completing his doctorate in 1953. A previous contributor to PETROLEUM REFINER, Dr. Holland is co-author of two articles published in 1954. His "Design Methods for Reactors" appeared in March 1954 and "Designing Fired Tubular Reactors" in June.

J. F. WOODHAM is an assistant professor of chemical engineering at Lamar State College in Beaumont, Texas. A member of the faculty there since last fall, he is scheduled to receive a Ph.D. in chemical engineering at Texas A&M College later this year. Woodham's industrial experience includes three years with Jefferson Chemical Company as a process engineer at its Port Neches, Texas, plant. He joined the company in 1948, following graduation from Texas A&M with his first degree in chemical engineering. He completed his master's degree at Texas A&M in 1953.

By comparison of these equations, it is evident that the equations describing a batch filtration can be used for rotary filter calculations, provided the variables are redefined to have the meaning of those in Equation (12). Ruth and Kempe's[3] treatment of continuous filters was different from that shown herein. They began with the equations for a batch filter and reasoned by a process of summation that the same equations could be used for a continuous filter. Since Equation (12) is not very convenient for calculational purposes, a more convenient relationship is obtained by returning to Equation (9) and replacing t by its equivalent in terms of θ. This gives upon integration

$$F = k_2 \sqrt{(-\triangle P_e)\,\alpha\theta_T} \qquad (14)$$

and where the resistance of the cloth and lines is considered

$$F + F_e = k_2 \sqrt{(-\triangle P_e)\,\alpha\,(\theta_T + \theta_e)} \qquad (15)$$

where

$$k_2 = Dh\sqrt{\frac{\pi k_2}{2}}$$

Generally, the depth of submergence, d, is more readily available than is the central angle, θ_T. The trigonometrical relationship of these quantities is

$$\cos\frac{\theta_T}{2} = \left(1 - \frac{2d}{D}\right), \text{or } \frac{\theta_T}{2} = \cos^{-1}\left(1 - \frac{2d}{D}\right) \qquad (16)$$

In the above equations the variation of $\triangle P$ with the hydrostatic head was neglected. A more exact expression for F is obtained as indicated below. The variation of $\triangle P$ with the hydrostatic head of the slurry is given by

$$-\triangle P = -\triangle P_e + \frac{\rho_r D}{2}\left[\cos\left(\frac{\theta_T}{2} - \theta\right) - \cos\frac{\theta_T}{2}\right] \qquad (17)$$

where the depth of liquid in the drum is negligible. Substituting the above expression in Equation (2) and following the same procedure outlined previously, it follows:

$$F = k_2\sqrt{\left[\left(-\triangle P_e - \frac{\rho_r D}{2}\cos\frac{\theta_T}{2} + \frac{\rho_r D}{\theta_T}\sin\frac{\theta_T}{2}\right)\right]\,\alpha\theta_T} \qquad (18)$$

It should be pointed out that the units of $\rho_r D$ in Equation (18) should be the same as those used for pressure drop. Where the resistance of the cloth and lines is not neglected, the corresponding equation is

$$F + F_e = k_2\sqrt{\left[-\triangle P_e - \frac{P_r D}{2}\cos\frac{\theta_T}{2} + \frac{P_r D \sin\left(\frac{\theta_T + \theta_e}{2}\right)\cos\frac{\theta_e}{2}}{(\theta_T + \theta_e)}\right]\alpha\,(\theta_T + \theta_e)} \qquad (19)$$

Illustrative Example—A vacuum rotary filter delivers 50 gallons of filtrate per minute. The depth of submergence is 1/5 the diameter of the drum. The speed of rotation is 5 revolutions per minute. Neglecting the resistance of the cloth and lines, and the variation in pressure drop due to hydrostatic head, calculate the rate of delivery of filtrate corresponding to each of the following changes.

(a) The depth of submergence is doubled.

(b) The area of submergence is doubled.

(c) The speed of rotation is doubled.

(d) The pressure drop is doubled.

Solution:

Part (a):

By Equation (14), the final delivery rate, F_2, is related to the initial delivery rate, F_1, as follows:

$$F_2 = F_1\sqrt{\frac{\theta_{T2}}{\theta_{T1}}}$$

Calculation of θ_{T1} and θ_{T2}:

$$\cos\frac{\theta_{T1}}{2} = \left(1 - \frac{2d}{D}\right) = 1 - \frac{2}{5} = \frac{3}{5}$$

$$\frac{\theta_{T1}}{2} = 53.133°,\ \theta_{T1} = \left(106.266°\right)\left(\frac{3.1416}{180°}\right)$$

$$\theta_{T1} = 1.85 \text{ radians}$$

$$\cos\frac{\theta_{T2}}{2} = \left(1 - \frac{2d}{D}\right) = 1 - \frac{4}{5} = \frac{1}{5}$$

$$\frac{\theta_{T2}}{2} = 78.467°,\ \theta_{T2} = \left(156.934°\right)\left(\frac{3.1416}{180°}\right)$$

$$\theta_{T2} = 2.74 \text{ radians}$$

Therefore,

$$F_2 = 50\sqrt{\frac{2.74}{1.85}} = 60.8 \text{ gpm}$$

Part (b)

$$F_2 = 50\sqrt{\frac{2\theta_{T1}}{\theta_{T1}}} = 50\sqrt{2} = 70.7 \text{ gpm}$$

Part (c)

$$F_2 = 50\sqrt{\frac{\alpha_2}{\alpha_1}} = 70.7 \text{ gpm}$$

Part (d)

$$F_2 = 50\sqrt{\frac{(-\triangle P_2)}{(-\triangle P_1)}} = 70.7 \text{ gpm}$$

NOTATION

a—Area of filter medium covered with a cake of uniform thickness.

A—Filtering area of drum beneath the surface of slurry.

$\bar{A}$—Filtering area of a batch filter press.

D—Average diameter of the cake and the drum.

d—Depth of submergence of drum.

F—Volumetric delivery rate of filtrate.

F_e—Volumetric delivery rate corresponding to the equivalent thickness L_e for a rotary filter.

k_1—Constant in Equation (2). Dependent on physical properties of the cake and the filtrate. See page 217 of Reference (1).

h—Length of drum of rotary filter.

k_2—Constant in Equation (8).

$$k_2 = \frac{2k_1(1 - X)P_s}{r\rho}.$$

k_3—Constant in Equation (14).

$$k_3 = Dh\sqrt{\frac{\pi k_2}{2}}.$$

L—Thickness of cake.

L_e—Thickness of cake equivalent to the resistance of the filter cloth and lines.

$-\triangle P$—Decrease in pressure responsible for the flow of filtrate through the cake.

$-\triangle P_e$—Pressure drop across cake. In the case of a rotary filter, this symbol represents the pressure drop (exclusive of the hydrostatic head of the slurry across the cake).

r—Ratio of mass of dry cake to mass of filtrate.

t—Time required for a point on the periphery of the drum to pass through either the angle θ or θ_T, as indicated by context.

$\bar{t}$—Time required to filter a volume $\bar{V}$ in a batch filter press.

t_e—Time required to deposit the equivalent thickness L_e for a rotary filter.

$\bar{t}_e$—Time required to deposit the equivalent thickness $\bar{L}_e$ for a batch filter press.

v—Instantaneous or point value of the linear velocity of filtrate.

v_e—Used to denote the fact that the expression for the velocity has been corrected to include a term corresponding to the resistance of the cloth and line.

V—Volume of filtrate delivered in time t by a rotary filter.

V_e—Volume of filtrate necessary to deposit the equivalent thickness of cake, L_e.

$\bar{V}$—Volume of filtrate delivered in time $\bar{t}$ by a batch filter press.

X—Porosity of cake; volume of void space in cake divided by the total volume of the cake.

Greek Letters:

α—Speed of rotation of drum in revolutions per unit time.

π—3.1416 radians.

ρ—Density of filtrate.

ρ_r—Density of the slurry.

ρ_s—Density of solid particles in the cake.

θ_T—Angle of submergence, measured as indicated in Figure 1, expressed in radians.

θ—Measured in same direction as θ_T and has values from zero to θ_T.

θ_e—Angle corresponding to t_e.

LITERATURE CITED

[1] Brown, G. G., and Associates, "Unit Operations," John Wiley & Sons, Inc., New York, 210-257 (1950).

[2] Ruth, B. F., Ind. Eng. Chem., 27, 708, 806 (1935).

[3] Ruth, B. F., and Kemp, L. L., Trans. Am. Inst. Chem. Engrs., 33, 34 (1937).

[4] Ruth, B. F., Montillon, G. H., and Montonna, R. E., Ind. Eng. Chem., 25, 76, 153 (1933).

ACKNOWLEDGMENT

This work was supported in part by the Texas Engineering Experiment Station, College Station, Texas. This aid is gratefully acknowledged.

REFINING FORECAST:

$20.1 Billion Outlay By 1965

Chase Manhattan Bank Predicts:

- **$11.4 billion U. S. expansion to meet 53% demand increase.**
- **$8.7 billion outlay abroad to meet 103% demand increase.**

THIS IS THE refining industry's future as predicted by the Chase Manhattan Bank:

- To meet the soaring world demand—expected to increase 74 percent in 10 years—refiners will invest approximately $20.1 billion in expansion by 1965.
- An estimated $11.4 billion growth in U. S. refining facilities will be needed to supply the domestic demand for 12.8 million barrels of oil products daily in 1965—a 53 percent increase over 1955.
- Consumption abroad will jump 103 percent to 12 million barrels per day, almost matching U. S. demand. To meet this skyrocketing demand, investment in refining facilities abroad will be increased $8.7 billion.

This look into the oil industry's future is the result of an analysis made by Joseph E. Pogue and Kenneth E. Hill of the Chase Manhattan Bank.

They predict that the oil industry as a whole will invest about $115 billion for expansion in the next 10 years —nearly twice the annual budget of the U. S. An expected $66.6 billion will be spent for exploration and production, and $28.3 billion for transportation, marketing research, etc.

In their demand predictions for U. S. refined products, the authors give two projections: One is based on past yearly trends—the other on modified trends, i.e., some of the products are in dynamic phase while others have shifted their trends.

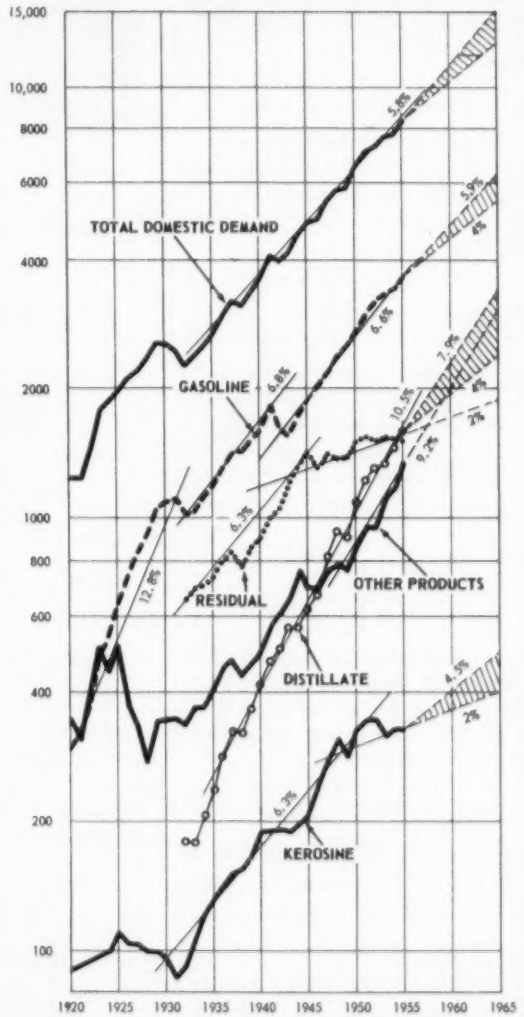
According to past trends, gasoline demand will increase 5.9 percent annually for the next 10 years with 1964 consumption totaling 6.4 million barrels daily. Last year, gasoline demand averaged 3.6 million barrels per day. The modified trend projection shows a 4 percent annual increase in demand, reaching a 5.4 million barrels-per-day consumption rate in 1965.

If distillate demand follows past trends it will show a marked increase of 7.9 percent a year with 3.4 million barrels a day being consumed in 1965. This compares with 1.6 million barrels per day in 1955. The modified prediction indicates an annual demand increase of 4 percent with daily consumption averaging 2.35 million barrels in 10 years.

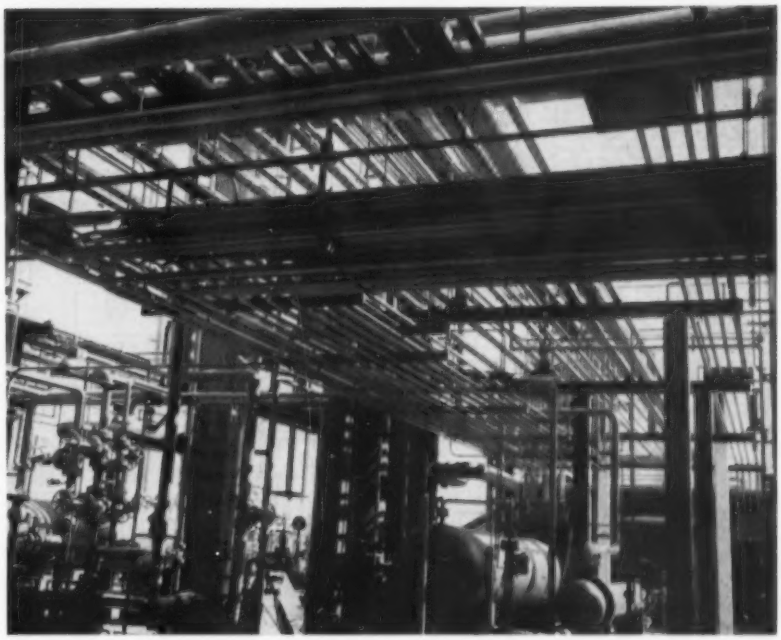
Other products (jet fuel, asphalt, petrochemicals, etc.) will continue their rapid growth. With an average annual increase (based on past trends) of 9.2 percent, daily consumption of these products will average 3.2 million barrels daily in 1965 compared to 1.3 million barrels daily last year. The modified prediction is almost the same. ##

TREND AND PROJECTION DEMAND IN U. S. FOR PRINCIPAL PETROLEUM PRODUCTS

(Thousands of Barrels Per Day)



Rate of growth of demand for principal petroleum products in U. S. by years, 1920-1955, with projections to 1965.



Connections of pumps, heat exchangers, and related equipment to process piping.

Here's how to save time in computing stresses in a three-dimensional piping system:

New Method for Pipe Stresses

Part 1. How to Handle the Tabular Method

Part 2. Systems with Different Moments of Inertia

Part 3. How to Handle Elbows and Bends

K. Hao Hsiao,
The Ralph M. Parsons Company,
Los Angeles

When a piping system contains circular 90-degree elbows or quarter bends,* each of these elbows contributes greater flexibility than that of its true length to the system. This increased flexibility of elbow is accounted for by using an "Equivalent Length," l_e (instead of the true length for an elbow), whose plane is parallel to the plane of line inertia under consideration. For an elbow, whose plane is perpendicular to the plane of line inertia under consideration, a "Projected Equivalent Length," l_e', is used. The formulae for these lengths and their respective line inertias are given in Eqs. (17) for an elbow parallel to X-Y plane shown in Figure 5.

X-Y plane	X-Z and Y-Z planes
$l_e = l_e'(1+\omega) = 1.806R(1+\omega)$	$l_e' = 1.806R$
$I_{ox} = .171R^3(1+\omega)$	$I_{ox} = .171R^3$
$I_{oy} = .171R^3(1+\omega)$	
$I_{oxy} = .158R^3(1+\omega)$	

(17)

where R is the radius of curvature of elbow (ft.), I_{oxy} is the centroidal product of inertia of elbow, and I_{ox}, I_{oy}, I_{oz}, x, y and z have the same meanings as in Eqs. (10). ω is the flexibility modification factor. It is a function of λ, which, in turn, is a function of characteristics of the elbow as shown in Eqs. (18) and (19):

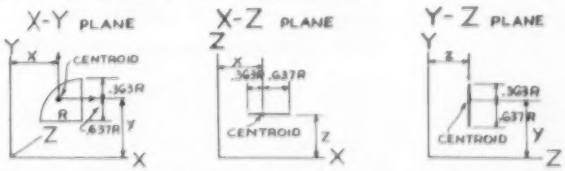


FIGURE 5—An elbow parallel to the X-Y plane.

$$\omega = \frac{7.8\lambda}{12\lambda^2 + 1} - .131 \qquad (18)$$

$$\lambda = \frac{12tR}{r^2} \qquad (19)$$

where R = radius of curvature of elbow (ft.)
t = elbow wall thickness (in.)
r = mean elbow radius (in.)

It is evident from Eqs. (17) that the factor ω changes the projected equivalent length of a circular elbow to its equivalent length, whose plane is parallel to the plane of line inertia. It also modifies the line inertia values of the former, and changes them to those of the latter. Therefore, its function and application are similar to those of the constant 0.3 for straight piping branches, which mod-

* Since elbows and quarter bends are treated the same way, the term "elbow" will be used henceforth for either one.

BRANCH OR ELL	X	Y	Z	l	lx	lx^2	ly	ly^2	lz	lz^2	lxy	lxz	lyz
ab	+9.25	-6.5	-8.75	7.5	+69.4	641	-48.8	317	-65.6	575.0	-451	-607	+426
bc	+7.43	-6.5	-1.82	9.03	+67.1	498	-58.7	382	-16.4	29.9	-436	-122	+107
cd	0	-6.5	0	8.5	0	0	-55.3	359	0	0	0	0	0
de	-7.43	-4.68	0	9.03	-67.1	498	-42.3	198	0	0	+314	0	0
ef	-9.25	0	0	3.0	-27.8	257	0	0	0	0	0	0	0
fg	-7.43	+4.68	0	9.03	-67.1	498	+42.3	198	0	0	-314	0	0
gh	+9.75	+6.5	0	16.0	+60.0	225	+104	676	0	0	+390	0	0
	(1) BASIC SUM			62.1	+34.5	2617	-58.8	2130	-82.0	604.9	-497	-729	+539
X-Y	(2) SUM OF ELBOWS PARA. TO X-Y: de + fg			18.06	-134.2	996	0	396			0		
	(3) = (2) × ω (ω = 1.19)			21.5	-159.9	1185	0	471			0		
	(4) SUM OF BRANCHES PARA. TO Z-AXIS: ab												
	(5) = (4) × 0.3			2.25	+20.8	192.3	-14.64	95.1			-135.3		
	(6) Σ = (1) + (3) + (5)			85.9	-104.6	3994	-73.4	2696			-632		
	(7) SEE NOTES				$\bar{x}$ -1.22	(A) +128	$\bar{y}$ -8.55	(B) +62.7			(C) +89.5		
	(8) = (6) - (7)					I'_y 3866		I'_x 2633			I'_{xy} -722		
X-Z	(9) SUM OF ELBOWS PARA. TO X-Z: bc												
	(10) = (9) × ω (ω = 1.19)			10.7	+79.8	593			-19.50	35.6		-145	
	(11) SUM OF BRANCHES PARA TO Y-AXIS: ef												
	(12) = (11) × 0.3			0.9	-8.33	77.1			0	0		0	
	(13) Σ = (1) + (10) + (12)			73.7	+106.0	3287			-101.5	640.5		-876	
	(14) SEE NOTES				$\bar{x}$ +1.44	(D) +1525			$\bar{z}$ -1.98	(E) +1400		F) -146	
	(15) = (13) - (14)					I'_z 3135				I''_x 5005		I'_{xz} -728	
Y-Z	(16) SUM OF ELBOWS PARA. TO Y-Z:												
	(17) = (16) × ω (ω = 1.19)												
	(18) SUM OF BRANCHES PARA TO X-AXIS: cd + gh			24.5			48.7	1035	0	0			0
	(19) = (18) × 0.3			7.35			14.6	310.5	0	0			0
	(20) Σ = (1) + (17) + (19)			69.5			-44.2	2441	-82	605			+533
	(21) SEE NOTES						$\bar{y}$ -.636	(G) +28.1	$\bar{z}$ -1.18	(H) +96.6			(K) +52.1
	(22) = (20) - (21)							I''_z 2413		I''_y 508			I'_{yz} +481
(23) SEE NOTES						I_{ox} 564.4		I_{oz} 526.3		I_{ox} 177.8	I_{oxy} 0	I_{oxz} -43	I_{oyz} 0
(24) $I'_x + I''_x + I_{ox} = I_x$, $I'_y + I''_y + I_{oy} = I_y$, $I'_z + I''_z + I_{oz} = I_z$						I_y 4938		I_z 6074		I_x 3311	I_{xy} -722	I_{xz} -771	I_{yz} +481
$I'_{xy} + I_{oxy} = I_{xy}$, $I'_{yz} + I_{oyz} = I_{yz}$, $I'_{xz} + I_{oxz} = I_{xz}$ (25) = FROM (24)						I_{xy} -722		I_{xz} -771			I_x 3311	I_x 3311	I_{oy} -722 I_{oz} -771
(26) = (24) ÷ (25)						(P) -6.84		(T) -7.86			(L) -.218	(M) -.293	(Q) -.666 (S) -.623

NOTES

$\bar{x} = \frac{\sum lx}{\sum l}$ (A), (D) $= \bar{x}\sum lx$ (F) $= \bar{z}\sum lx$

$\bar{y} = \frac{\sum ly}{\sum l}$ (B), (G) $= \bar{y}\sum ly$ (C) $= \bar{y}\sum lx$

$\bar{z} = \frac{\sum lz}{\sum l}$ (E), (H) $= \bar{z}\sum lz$ (K) $= \bar{z}\sum ly$

$\frac{\sum l_x^3}{12} = \frac{8.5^3}{12} + \frac{16^3}{12} = 393$

$\frac{\sum l_y^3}{12} = \frac{3^3}{12} = 2.2$

$\frac{\sum l_z^3}{12} = \frac{7.5^3}{12} = 35.2$

(N) $= \frac{d_x cI}{I_x} = \frac{2.5(1168)300.3}{3311} = 265$

(R) $= \frac{d_y cI}{I_{xy}} = \frac{30(1168)300.3}{-722} = -14570$

(U) $= \frac{d_z cI}{I_{xz}} = \frac{25(1168)300.3}{-771} = -11970$

$I_{ox} = 37.4 + .171(125)3(2.19) = 177.8$ $I_{oy} = 428 + .171(125)[2(2.19) + 2] = 564.4$ $I_{oz} = 394 + .171(125)[2.19 + 2(2)] = 526.3$

$I_{oxy} = 0$ $I_{oxz} = 0$ $I_{oyz} = -.158(125)(2.19) = -43.3$

TABLE 1A—Moments and products of inertia for systems with elbows: Data from "Example 3" are inserted.

ifies the length of a straight piping branch parallel to the plane of line inertia to the torsional equivalent length of the same straight branch perpendicular to the plane of line inertia. As shown before, this constant also changes the line inertia values of a straight branch to those of a branch in torsion. Numerical values of ω can be quickly obtained from ω vs. λ curve in Figure 7.

It is evident from Eqs. (17) that for any circular 90-degree elbow, each of the centroidal moments of inertia about its own centroidal axes in its own plane is .171 R^3 $(1 + \omega)$ and the total moment of inertia about the third axis perpendicular to its own plane is .342 R^3. The centroidal product of inertia in its own plane is .158 R^3 $(1 + \omega)$. Therefore, the generalized expressions for line inertia values when there are more than one elbow, having the same radius of curvature R, are

$$I_o = .171\ R^3[m(1 + \omega) + 2n] \quad (20)$$

$$I_{op} = .158\ R^3(1 + \omega)\ \Sigma \pm \text{signs} \quad (21)$$

where I_o = sum of centroidal moments of inertia of all elbows about the axis of I_o. The subscript o represents ox or oy or oz.

I_{op} = sum of centroidal products of inerita of all elbows parallel to the plane of I_{op}. The subscript op represents oxy or oxz or oyz.

m = number of elbows in planes parallel to the axis of I_o.

n = number of elbows in planes perpendicular to the axis of I_o.

The selection of sign for Eq. (21) depends upon the positive directions of centroidal axes of each elbow parallel to plane of line inertia.* When only the positive direction of one centroidal axis cuts through the elbow circle, the term .158 R^3 $(1 + \omega)$ is a positive value. Otherwise, it is a negative value. Therefore, Eq. (21) is the algebraic sum of all $\pm$ .158 R^3 $(1 + \omega)$ values for elbows parallel to plane of I_{op}, i.e., $\Sigma \pm$ signs is the algebraic sum of all the positive and negative signs of products of inertia for elbows parallel to plane of I_{op}. Take, for instance, the

* Same as the positive directions of axes of piping system.

elbow in X-Y plane of Eqs. (17). Since in this case the positive direction of only one centroidal axis of the elbow in X-Y plane cuts through the elbow circle, we use $+ .158\ R^3\ (1 + \omega)$. When the numbers of positive and negative signs are equal, $I_{op} = 0$. In this case, it is not necessary to calculate I_{op} regardless of the total number of elbows in the system.

Combining the I_o terms in Eqs. (10) with Eqs. (20), we obtain the total I_o terms for both straight branches and elbows as shown below:

$$\left.\begin{aligned} I_{ox} &= \frac{1}{12}\sum (l_y^2 + l_z^2) + .171\ R^3\ [m_x(1+\omega) + 2n_x] \\ I_{oy} &= \frac{1}{12}\sum (l_x^2 + l_z^2) + .171\ R^3\ [m_y(1+\omega) + 2n_y] \\ I_{oz} &= \frac{1}{12}\sum (l_x^2 + l_y^2) + .171\ R^3\ [m_z(1+\omega) + 2n_z] \end{aligned}\right\} \quad (22)$$

In the general case, when the elbows in a piping system do not have same radius of curvature R, then the generalized expression of Eq. (22) is

$$I_o = .171 \sum_{\substack{\text{i = Elbows} \parallel \\ \text{Axis of } I_o}} R_i^3\ (1 + \omega_i) + .342 \sum_{\substack{\text{i = Elbows} \perp \\ \text{Axis of } I_o}} R_i^3 + \frac{1}{12} \sum_{\substack{\text{i = Branches} \perp \\ \text{Axis of } I_o}} l_i^3 \quad (23)$$

The I_{op} term in this case is, from Eq. (21),

$$I_{op} = .158 \sum_{\text{i = Elbows} \parallel \text{ Plane of } I_{op}} \pm R_i^3\ (1 + \omega_i) \quad (24)$$

The I_{op} terms in Eq. (24) exist only for piping system containing elbows. Thus, it is seen that Eqs. (23) and (24) provide the means for quick summation of centroidal line inertia terms of all elbows and straight branches in a piping system.

The complete expressions of line inertias for piping system containing elbows and straight branches can be obtained by substituting l_e or l_e' of Eqs. (17) for length of each elbow in Eq. (10) and using Eqs. (23) and (24) for total centroidal line inertias. Since l_e' for an elbow corresponds to l of a straight branch and is to be tabulated and applied in Table 1A in the same way as l, we use, for simplicity, the symbol l for l_e' and $l(1 + \omega)$ for l_e in the following equations for line inertias. Thus, from Eq. (10)

$$\begin{aligned} I_x = {} & \left.\begin{aligned} & \sum_{\text{i = all Bran.; all Elbows}} l_i y_i^2 + 0.3 \sum_{\text{i = Bran.} \parallel \text{ Z-axis}} l_i y_i^2 \\ & + \sum_{\text{i = Elbows} \parallel \text{ X-Y Plane}} l_i y_i^2 \omega_i \\ & - \bar{y}^2 \left[\sum_{\text{i = all Bran.; all Elbows}} l_i + 0.3 \sum_{\text{i = Bran.} \parallel \text{ Z-axis}} l_i \right. \\ & \left. + \sum_{\text{i = Elbows} \parallel \text{ X-Y Plane}} l_i \omega_i \right] \end{aligned}\right\} \text{X-Y Plane} \\ & \left.\begin{aligned} & + \sum_{\text{i = all Bran.; all Elbows}} l_i z_i^2 + 0.3 \sum_{\text{i = Bran.} \parallel \text{ Y-axis}} l_i z_i^2 \\ & + \sum_{\text{i = Elbows} \parallel \text{ X-Z Plane}} l_i z_i^2 \omega_i \\ & - \bar{z}^2 \left[\sum_{\text{i = all Bran.; all Elbows}} l_i + 0.3 \sum_{\text{i = Bran.} \parallel \text{ Y-axis}} l_i \right. \\ & \left. + \sum_{\text{i = Elbows} \parallel \text{ X-Z Plane}} l_i \omega_i \right] \end{aligned}\right\} \text{X-Z Plane} \\ & + I_{ox} \end{aligned} \quad (25)$$

where

$$\left.\begin{aligned} I_{ox} = {} & .171 \sum_{\text{i = Elbows} \parallel \text{ X-axis}} R_i^3\ (1 + \omega_i) + .342 \sum_{\text{i = Elbows} \perp \text{ X-axis}} R_i^3 \\ & + \frac{1}{12} \sum_{\text{i = Branches}} (l_y^2 + l_z^2)_i \end{aligned}\right\} \quad (26)$$

From Eq. (10),

$$\begin{aligned} I_{xy} = {} & \sum_{\text{i = all Bran.; all Elbows}} l_i x_i y_i + 0.3 \sum_{\text{i = Bran.} \parallel \text{ Z-axis}} l_i x_i y_i \\ & + \sum_{\text{i = Elbows} \parallel \text{ X-Y Plane}} l_i x_i y_i \omega_i \\ & - \bar{x}\bar{y} \left[\sum_{\text{i = all Bran.; all Elbows}} l_i + 0.3 \sum_{\text{i = Bran.} \parallel \text{ Z-axis}} l_i \right. \\ & \left. + \sum_{\text{i = Elbows} \parallel \text{ X-Y Plane}} l_i \omega_i \right] \\ & + I_{oxy} \end{aligned} \quad (27)$$

where

$$I_{oxy} = .158 \sum_{\text{i = Elbows} \parallel \text{ X-Y Plane}} \pm R_i^3\ (1 + \omega_i) \quad (28)$$

Equations for I_y, I_z and I_{oy}, I_{oz} are similar to Eq. (25) and Eq. (26) respectively. Equations for I_{xz}, I_{yz} and I_{oxz}, I_{oyz} are similar to Eq. (27) and Eq. (28), respectively.

Comparing Eqs. (25) and (27) with Eq. (10), it is seen that the additional terms in the former are I_o terms for elbows and terms including ω. Since the I_o's can be quickly obtained from Eqs. (23) and (24), or (26) and (28), only the terms including ω are calculated and tabulated in Table 1A in exactly the same manner as the terms including the constant 0.3 for straight branches in Table 1.

Therefore, the only additional tabulations in the former table are rows containing products of ω and numerical values of each elbow from the "Basic Table." For instance, if there are two elbows with different R's and hence different ω's in the X-Y plane, then two additional rows, each containing the products of numerical values of one elbow from "Basic Table" and its ω, are added. Similarly, additional rows are added to X-Z and Y-Z planes to account for terms including ω for elbows in these planes, i.e., one row for each elbow.

In most cases which an analyst encounters, R and ω are constant throughout the whole system. In such cases, the factors ω_i and R_i in Eqs. (25), (26), (27) and (28) become constants ω and R, which are placed in front of the summation signs, and Eqs. (26) and (28) are changed to their simpler forms, i.e., Eqs. (22) and (21), respectively. Consequently, rows (2), (9) and (16) are added for sums of values for elbows in X-Y, X-Z and Y-Z planes respectively, and rows (3), (10) and (17) for products of these sums and their corresponding ω's. These rows are shown in Table 1A. The numerical values of centroidal moments of inertia I_o are listed in Table 1A, row (23).

When the piping system contains only one elbow in each plane, the necessary additional tabulations are reduced to one row for each plane, i.e., rows (3), (10) and (17). Rows (2), (9) and (16) may be left blank. Consequently, the analyst can apply this calculation method

(1)		-(L) .218	-(M) .233	(N) 265
(2)		(P) -6.840	-(Q) .666	(R) -14,570
(3)		-(S) .623	(T) -7.860	(U) -11,370
(4)	(1)+(2)	-6.622	-(a) .899	-14,305
(5)	(1)+(3)	.841	(b) -7.627	-11,105
(6)	(5)x(a)/(b)	-(c) .099	(a) -.899	(d) -1,310
(7)	(4)+(6)	(e) -6.523		(f) -15,615

$$Y = \frac{(f)}{(e)} \quad \frac{-15,615}{-6.523} = 2,395 \text{ lb.}$$

$$Z = \frac{(d)+(c)Y}{(a)} = \frac{-1,310 - .099(2,395)}{-.899}$$

$$= 1,720 \text{ lb.}$$

$$X = (N)+(L)Y+(M)Z$$

$$= 265 - .218(2,395) - .233(1,720)$$

$$= -658 \text{ lb.}$$

TABLE 2—Forces: Data from Example 3 are inserted.

to a piping system containing circular elbows almost as efficiently and expediently as a system without elbows.

Bending Stress in Elbows

The bending stress in an elbow due to the moment in plane of elbow is a function of the stress coefficient β. In a single-plane piping system, the bending stress in an elbow is

$$f_b = \frac{\beta M}{S} \qquad (29)$$

where M = bending moment at the elbow (in.-lb.)
S = section modulus of the elbow (in.³)

In computing bending stress in a three-dimensional system, the coefficient β is applied in the plane of the bend only. The numerical values of β can be obtained from the β vs. λ curve in Figure 7.*

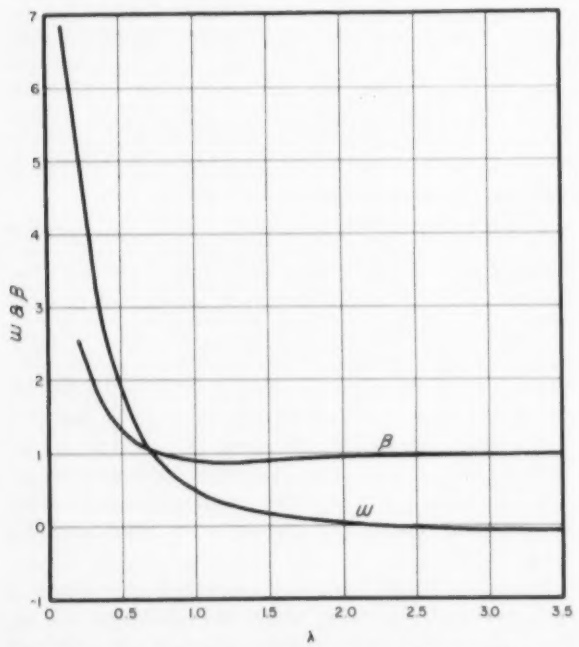
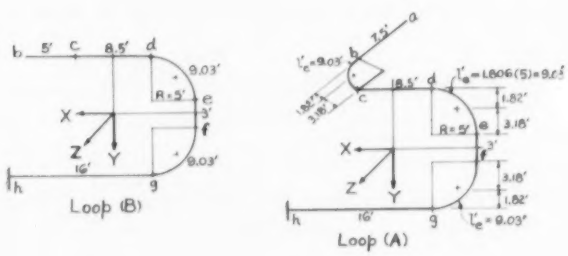


FIGURE 7—Numerical values can be obtained quickly from this curve.

* See "Piping Stress Calculations Simplified," S. W. Spielvogel, p. 70.

Example 3

In piping stress problems, the selection of the critical portion of a complicated piping system for analysis and the assumption of its end conditions are as important as the analysis itself. The former determines the length and flexibility of the selected system and its nature (whether three-dimensional or single-plane), while the latter determines the position of centroid of system. Such selection and assumption depend upon individual experience and judgment, and hence vary with different analysts, resulting in different degrees of accuracy. In this example, the two loops shown in Figure 6 are assumed to be the critical portions, selected from a piping system for analysis, one being a three-dimensional system and the other a system in one plane subjected to displacement perpendicular to its own plane.



1% Cr.-½% Mol. Steel	T = 960° F
12 in. diam., sch. 40	c = 1168
D = 12.75 in.	$\lambda = \frac{12(.406)5}{6.17^2} = 0.64$
t = 0.406 in.	$\omega = 1.19$
I = 300.3 in.⁴	$\beta = 1.08$
S = 47.1 in.³	

FIGURE 6—The two critical loops in Example 3.

The lower end of each loop is connected to the nozzle at the top of a reactor which is 17 feet high and is assumed, for simplicity, to be at the same temperature as the pipe. Therefore, the total net length of thermal expansion along Y-axis is d_y = 30 feet. The upper end of each loop is assumed to be subjected to displacement in

	POINT / COORD.	a	b	c	d	e	f	g	h
	X	+9.25	+9.25	+4.25	-4.25	-9.25	-9.25	-4.25	+11.75
	Y	-6.5	-6.5	-6.5	-6.5	-1.5	+1.5	+6.5	+6.5
	Z	-12.5	-5	0	0	0	0	0	0
X-Y PLANE		$\bar{X}$ = -1.22			Y = 2.395#				
	X-$\bar{X}$	+10.47	+10.47	+5.47	-3.03	-8.03	-8.03	-3.03	+12.97
(1)	MULT. Y	+25,070	+25,070	+13,100	-7,260	-19,230	-19,230	-7,260	+31,080
		$\bar{Y}$ = -.855			X = -.659#				
	Y-$\bar{Y}$	-5.645	-5.645	-5.645	-5.645	-0.645	+2.355	+7.355	+7.355
(2)	MULT. X	-3,710	-3,710	-3,710	-2,710	-426	+1,550	+4,840	+4,840
(1)+(2)	M_{xy}	+21,360	+21,360	+9,390	-10,970	-19,656	-17,680	-2420	+35,920
X-Z PLANE		$\bar{X}$ = +1.46			Z = 1.720#				
	X-$\bar{X}$	+7.81	+7.81	+2.81	-5.69	-10.69	-10.69	-5.69	+10.31
(3)	MULT. Z	+13,690	+13,690	+4,850	-9,770	-18,380	-18,380	-9,770	+17,730
		$\bar{Z}$ = -1.38			X = -.659#				
	Z-$\bar{Z}$	-11.12	-5.62	+1.38	+1.38	+1.38	+1.38	+1.38	+1.38
(4)	MULT. X	-7,325	-2,380	+909	+909	+909	+909	+909	+909
(3)+(4)	M_{xz}	+6,365	+11,310	+5,759	-8,861	-17,471	-17,471	-8,861	+18,639
Y-Z PLANE		$\bar{Y}$ = -.696			Z = 1.720#				
	Y-$\bar{Y}$	-5.864	-5.864	-5.864	-5.864	-0.864	+2.136	+7.136	+7.136
(5)	MULT. Z	+10,080	+10,080	+10,080	+10,080	+1,487	-3,670	-12,280	-12,280
		$\bar{Z}$ = -1.18			Y = 2.395#				
	Z-$\bar{Z}$	-11.32	-5.82	+1.18	+1.18	+1.18	+1.18	+1.18	+1.18
(6)	MULT. Y	-27,150	-9,150	+2,827	+2,827	+2,827	+2,827	+2,827	+2,827
(5)+(6)	M_{yz}	-17,070	+980	+12,907	+12,907	+4,314	-843	-9,453	-9,453

MAX. $M = M_h = \sqrt{M_{xy}^2 + M_{xz}^2} = \sqrt{35,920^2 + 18,639^2}$ = 40,400 ft-lb

T_h = 9,453 ft-lb.

TABLE 3—Moments and torques: Data from Example 3 are inserted.

the Z-direction due to thermal expansion of a header at the same temperature and anchored at 12′-6″ from this end. Therefore, the net lengths for expansion along Z-axis for the three-dimensional and single-plane loops are d_z = 25 feet and d_z = 12.5 feet respectively.

Thus, for expansion, each piping-vessel system is fixed at the anchors. However, for flexibility, each loop is assumed to be fixed at both ends, i.e., points a and h for (A) and b and h for (B).* (Actual flexibility is greater). Calculations for loop (A) are in Tables 1A, 2 and 3.

The negative sign of the force X indicates that its true direction is opposite to that assumed in Figure 6. Since the stress coefficient for the bend in this case approaches unity, it does not appreciably affect the stress. Hence, the maximum combined moment and bending stress are at point h, i.e., the reactor nozzle. The pressure inside the system is assumed to be nil, so the axial stress f_p and the circumferential stress f_c are equal to zero. The calculations for combined stress is shown below:

$$f_t = \frac{40{,}400\ (12)}{47.1} = 10{,}300 \text{ psi}$$

$$f_s = \frac{9{,}453\ (12)}{2\ (47.1)} = 1{,}204 \text{ psi}$$

$$f = \tfrac{1}{2}\ [10{,}300 + \sqrt{4\ (1{,}204)^2 + 10{,}300^2}] = 10{,}440 \text{ psi}$$

The calculations for loop (B) are given in Table 4, which is a revised version of Table 1A and is based on the following equations: Substituting $I_{xz} = I_{yz} = 0$ in

COORD. / BRANCH	x	y	l	lx	lx^2	ly	ly^2	lxy
bc	r 6.75	-6.5	5	33.75	228	-32.5	211	-219.4
cd TO gh			46.56	-101.98	1678	+48.7	1481	+380
(1) BASIC SUM			50.56	-68.2	1706	+16.2	1642	+170.6
(2) = (de + fg) x ω $^2_{386}$			21.50	-159.9	1185	0	471	0
(3) $\sum$ = (1) + (2)			72.06	-228.1	2891	+16.2	2113	+170.6
(4) SEE NOTE, TABLE 1A				$\bar{x}$ = 3.17	(A) 722.5	$\bar{y}$ r 225	(B) 3.64	(C) -51.5
(5) SEE NOTE BELOW					I_{ay} 691.5		I_{ax} 95.96	I_{axy} 0
(6) = (3) - (4) + (5)					I_y 2666		I_x 2205	I_{xy} 221.9
(7) FROM (6)				I_{xy}/I_{xz}	I_{xy} 221.9		I_{xy}/I_x	I_{xy} 2205
(8) = (6) ÷ (7)					12			.101
(9) = ef x 0.3			.9	-6.33	77.1			
(10) $\sum$ = (1) + (9)			51.46	-74.53	1783			
(11) SEE NOTE, TABLE 1A				$\bar{x}$ = 1.485	(D) 118.7			
(12) = (10) - (11)					I'_x 1664			
(13) = bc + cd + gh			29.5			r 16.2	1246	
(14) = (13) x 0.3			8.85			4.86	373.8	
(15) $\sum$ = (13) + (14)			38.41			r 21.1	2019.8	
(16) SEE NOTE, TABLE 1A						$\bar{y}$ r 3.36	(E) 7.50	
(17) = (15) - (16)							I''_x 2008	
(18) SEE NOTE BELOW							I_{ax} 451.4	
(19) = $I'_x + I''_x + I_{ax}$							I_x 4168	

NOTES

$\sum \frac{l^2}{12} = \frac{5^2}{12} + \frac{8.5^2}{12} + \frac{15^2}{12} = 403.6$

$\sum \frac{lh}{12} = \frac{\Delta^2}{12} = 2.25$

$\sum \frac{lk}{12} = 0$

ROWS (2) & (8) ARE FROM TABLE 1A, ROWS (3) & (12). ( ) OF ROW (13) IS FROM T. 1A, ROW (18). @ IS FROM T.1A

$I_{ax} = 2.25 + .17(125) + 2(2.19) + 95.95$

$I_{ay} = 403.6 + .17(125) + 2(2.19) + 691.5$

$I_{az} = 403.6 + 2.25 + .17(125)2(2) + 691.5 = 35$

$d_x cI = \frac{2.5(1168)\ 300.3}{2205} = 398$

$d_y cI = \frac{50(1168)\ 300.3}{221.9} = 47{,}600$

$d_z cI = 12.5(1168)\ 300.3 = 4{,}380{,}000$

$I_{axy} = I_{axz} = I_{ayz} = 0$

TABLE 4—Moments and products of inertia for Loop (B).

Eqs. (5), (6) and (7), we obtain:

$$X - Y\left(\frac{I_{xy}}{I_x}\right) = \frac{d_x cI}{I_x} \tag{30}$$

$$-X + Y\left(\frac{I_y}{I_{xy}}\right) = \frac{d_y cI}{I_{xy}} \tag{31}$$

$$ZI_x = d_z cI \tag{32}$$

It is seen from Eqs. (30), (31) and (32) that the force acting in the direction of Z-axis is independent of expansions in the plane of the system, and the forces acting in the same plane are also independent of expansion along Z-axis.

Since loop (B) differs from loop (A) only in the elimination of section ab and changing the circular quarter bend bc to a straight section bc, the numerical values for the remaining sections in the former can be applied in Table 4 for the latter (see Notes for Table 4). Substituting the line inertias from Table 4 in Eqs. (30), (31) and (32), we have:

$$X - Y(.1) = 398$$

$$-X + Y(12) = 47{,}400$$

$$Z(4{,}168) = 4{,}380{,}000$$

$$Z = 1{,}050 \text{ lb.}\quad Y = 4{,}020 \text{ lb.}\quad X = 800 \text{ lb.}$$

The loop (B) described above is a special case of a single-plane system. Eliminating rows (9) to (19) inclusive in Table 4, we obtain a table for calculating line inertia values for any single-plane system in general, i.e., a system not subjected to displacement perpendicular to its own plane. Thus, Table 1, or Table 1A, when reduced to the form of Table 4, provides a tabulation method for the particular case in this example or other similar cases. When reduced further, Table 4, provides a means of tabulation for any simple single-plane system.

ACKNOWLEDGMENT

The author wishes to express his gratitude to John D. Mendenhall, chief structural engineer of Ralph M. Parsons Company, for his continued interest and encouragement.

* All piping systems in this paper are assumed to be fixed at both ends (for flexibility) where forces, moments and torques occur. However, the end "a" of each system is shown as temporarily free to expand in order to determine the directions of forces, X, Y and Z resisting expansion at "a." These forces are transferred to the centroid of system, where there is no moment or torque.

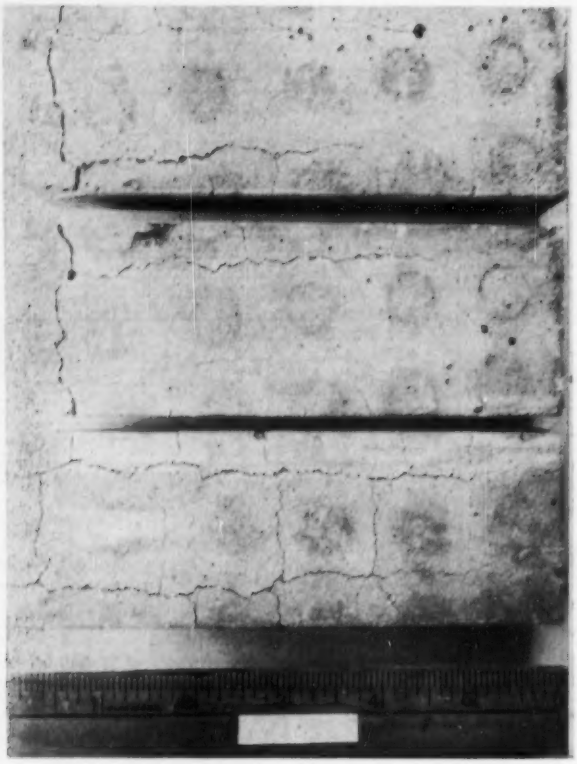


FIGURE 1—Cracking of a lightweight castable as a result of improper artificial drying. Maximum temperature of 500 F was attained faster than specified. Internal build-up of steam pressure caused the damage. Cracks outline spots, which correspond to holes in the electric oven tray.

New Tests on Castables

Here are the results . . . of an extensive study of high temperatures and process conditions on the performance of refractory castables.

C. M. Vogrin
Heinrich Heep
The M. W. Kellogg Company
New York

INTEREST IN THE application of castable linings has increased. This results from the successful use of such materials as early as 1946 in a fluid catalytic cracking unit regenerator and the growing acceptance by industry of similar applications. An investigation of the possible uses of castables for temperatures up to 2400 F in a reducing atmosphere of CO, H_2, CO_2, CH_4, and H_2O has been made.

The initial stages of investigation showed the need for a test program to clear up the following points:

1. The usual source of information concerning maximum service temperature and other physical data of castable refractories are the manufacturers' catalogs. Generally, the basis of such figures are not indicated. Especially difficult to define is the maximum service temperature. To a large extent, this figure is a matter of opinion depending on the assumed margin of safety. For a design which has to include provisions to handle runaway temperatures the knowledge of such margins becomes important.
2. Regarding hydraulic binders of castable materials, a divergence of opinion was found on the comparative merits of aluminous type cements (calcium aluminate) versus special portland cements (calcium silicate) developed for castables. While there seems to exist general acceptance of the merits of aluminous cement as a refractory material, the opinions on portland cement are divided.

In the course of the test program, the investigation was broadened to include applications which require protection not only against heat, but also corrosion and erosion.

Test Materials—The materials chosen for the investigation were considered representative of commercially available products. In common, these materials could be handled like ordinary concrete. They develop a hydraulic bond and when exposed to elevated temperatures, a ceramic bond. These materials, however, may be classified in groups according to the type of hydraulic binder or on the basis of their suitability for service conditions.

Considering the hydraulic binder, three variations exist:

1. Portland cement of the high early strength type.
2. Aluminous cement of the ordinary type as characterized by the analysis below:

Al_2O_3 — 36	— 39 percent
Ca O — 37	— 39 percent
$Si O_2$ — 5	— 5½ percent
Fe_2O_3 — 11	— 13 percent
Fe O — 4	— 5 percent
$Ti O_2$ — 1½	— 2 percent

3. High purity aluminous cement, a special calcium aluminate binder essentially featuring a reduced iron content of 1 percent or less combined with a corresponding higher percentage of alumina.

On a basis of their service the tested castables belong to the following groups:

1. Refractory castables, standard weight (100-130 pounds/cubic feet) with refractory qualities comparable to firebrick.
2. Insulating refractory castables—medium weight, (70-100 pounds/

cubic feet,) a compromise between insulating qualities, structural strength and erosion resistance for single liner application; light weight (30-50 pounds/cubic feet), where strength is sacrificed in favor of low conductivity.

3. Erosion resistant refractory castables.

Test Program—The test program was planned to obtain a qualitative classification of various refractory castables regarding stability at elevated temperatures in oxidizing as well as reducing atmosphere. Further, to gain better knowledge of what can be expected from specific hydraulic binders regarding temperature stability, and finally, to study the type of breakdown as well as its preceding circumstances for individual castables, when failure occurs due to temperature.

The test program included a graduated heat soaking test and a cyclic heating test, both in oxidizing atmosphere of air and a reducing atmosphere of illuminating gas. Each test specimen was subjected to one heat treatment only. The behavior of the specimens during the test as visually observed, their change in weight and linear dimensions were recorded.

During the progressive heat soaking test each charge was heated from ambient to test temperature as quick as the furnace allowed and soaked at this temperature for the remainder of eight hours. The specimens were then allowed to cool overnight and removed from the furnace prior to placing the next charge. See Table 1.

The cyclic heating test was a repetitive soaking following the same pattern with one cycle per day. The number of cycles in the beginning was 10 and later was reduced to 5. The cycling took place in oxidizing atmosphere between ambient and 1800 F or 2300 F. For reducing atmosphere, the range was between ambient and 1200 F, 1800 F or 2400 F.

Chemical analysis of unfired and fired specimens were made to determine relations between carbon depositions and iron content of the castable.

FIGURE 2—Failure of a lightweight castable induced by instability of hydrated compounds of calcium silicate cement after firing once at 1750 F in illuminating gas atmosphere. Specimen was removed from the furnace without defects. Photo depicts condition six months later.

After each cycle the furnace muffles were opened for inspection. A specimen was considered to have failed if either one of the following cases applied:

1. Specimen fuses
2. Specimen reveals signs of plastic deformation as a result of firing
3. Specimen cracks or crumbles seriously.

After the test, the fired specimens were stored at room temperature and periodically checked for six months.

Test Equipment—Since the test called for temperatures possibly up to 3000 F at various atmospheres, it was considered necessary to design a special electrical furnace. Four silicon carbide muffles of rectangular shape were arranged across the furnace. Each muffle held four test specimens measuring 2 inches x 2 inches x 6 inches. Temperature control was automatic by on and off temperature relay actuated from a control thermocouple in muffle No. 3. Temperature of each muffle was continuously recorded by a multipoint potentiometer. Up to 2000 F the control thermocouple was chromel alumel and the recording couples iron-constantan. Beyond 2000 F, all thermocouples were platinum-rhodium in protective porcelain wells.

Test Specimens—In casting the test specimens efforts were made to obtain the same consistency of wet mix for each material. The flow table procedure ASTM C91-40 was used to determine the necessary wet mix ratio. A flow of 75 percent provided sufficient workability to cast uniform specimens without drawing water to the surface. Specimens were cast vertically. Determination of initial and final set followed the Gillmore needle method in accordance with ASTM A191.

Test Results—The test data, observations, and the review of pertinent literature led to the following conclusions.

Temperature Stability.

Refractory castables (standard weight) recommended by manufacturers for maximum service temperature of 3000 F.

Castables belonging to this group basically combine a high purity alumina binder with an aggregate of either crushed alumina firebrick or calcined clay. The iron content of these mixes is low, about 1 percent or less and the percentage of aluminum high, up to 70 percent. As a result of the low iron content, the color is white or near white. During heat soaking plastic deformation set in at 2400-2500 F.

Softening gradually increased until fusion occurred slightly beyond the maximum recommended service temperature. Consequently, temperatures above 2400 F must be strictly limited to hot face temperatures if there is any appreciable load to be supported.

In general, materials of this group displayed stability during all tests under both oxidizing and reducing conditions for all soaking temperatures up to 2400-2500 F. Out of four materials tested, one castable was selected for liners of combustion chambers operating from 1700 to 2300 F and has given satisfactory service over an operating period of about two years.

Insulating refractory castables (medium weight) recommended by manufacturers for maximum service temperatures up to 2250 F.

Castables of this type are a mix of regular aluminous cement and an ag-

TABLE 1—
Heat Soaking Schedule

Charge No.	1	2	3	4	5	6
Soaking Temperature F.	1150	1500	1750	2000	2250	2500

gregate of Haydite and Dicalite or just Haydite. The iron content of these mixes varies between 5—10 percent.

During soaking at the maximum recommended service temperature of 2250 F indications of some softening were observed. However, when cycled at 1800 F in illuminating gas all materials of this group disintegrated or cracked considerably, but were stable during the same test in oxidizing atmosphere. Cracked specimens pressed between fingers crumbled into fine powder or black and rusty red color and generally unharmed pieces of aggregate. No other test produced failures of this type which evidently were caused by carbon depositions inside of castables containing more than 1¼ percent of iron. The temperature of 1800 F for this type of failure was surprising because the familiar case of carbon disintegration is more likely to occur at lower temperatures. The tentative ASTM Carbon Disintegration Test calls for temperatures of only 900-950 F.

Insulating refractory castables (light weight)

The light weight castables which were tested, contained a high early strength calcium silicate binder and aggregates such as crushed insulating brick, expanded vermiculite, perlite and diatomacious earth.

Maximum recommended service temperatures ranged from 1800-2000 F. No castable of this group was found unconditionally stable above 1300 F. In the range between 1500-1800 F, specimens cracked or crumbled particularly during cycling. Those recommended for up to 2000 F were stable at that temperature. At 2250 F all of them fused completely into a black or green glossy mass which covered the bottom of the muffle.

Moreover permanent shrinkage after exposure to temperatures above 1300 F was high. In some cases a shrinkage of 5 percent was measured for 1500-1700 F, compared with 0.2-0.3 percent for refractory concrete of standard weight under the same circumstances.

Some specimens cracked several months later after exposure to temperatures between 1500-1800 F.

Special care was necessary during artificial drying of light-weight castables. On account of their porous nature, more moisture is retained which developed a destructive steam pressure if temperatures were raised too fast (Figure 1).

FIGURE 3—Failure of an erosion resistant castable induced by instability of hydrated compounds of calcium silicate cement. Specimen on the left was fired at 1750 F and the other at 2000 F, both in oxidizing atmosphere. Specimens left the furnace without defects. Several days later deep cracks developed. Photo is three weeks later.

Erosion resistant refractory castables

These castables are recommended for erosion resistance up to 1200 F. Correlations are known to exist between erosion rate and compressive strength or fracture strength. For that reason the cement:aggregate ratio is on the cement rich side to provide maximum strength. A cement rich ratio in turn is detrimental at elevated temperatures when due to dehydration the hydraulic bond is diminished.

The materials tested contained a calcium aluminate or high early strength calcium silicate binder. The comparatively coarse aggregate was either crushed fire brick, silicon carbide or corhart.

Regarding temperature stability, the castables behaved as could be expected from their binders. For instance, the ones containing calcium silicate cement fused at 2250 F and with one exception also displayed unstability in the 1500-1800 F range.

Cementious Binder

Results indicate that the cementious binder proved to be the decisive factor influencing the stability of refractory castables.

Aggregates generally possess superior stability because they are either refractory material prefired to incipient fusion or stabilized in some other way. It is the cementious binder which undergoes drastic changes of its properties with temperature and atmosphere of exposure.

Specimens made from calcium silicate cement mixes revealed a general trend to fail after heating at temperatures of 1500-1750 F. The nature of failures included all intermediate steps from fine deep cracks to complete disintegration. The time when failures became noticeable ranged from several days to five months after removal from the furnace, except in reheating tests where failures occurred in the furnace. This obvious instability was observed in oxidizing as well as reducing atmosphere and more pronounced with light weight than heavier aggregates (Figures 2 and 3).

The reason generally given is that calcium silicate cements release free lime during dehydration which upon cooling tends to rehydrate or easily reacts with other elements. The release of calcium oxide increases with the amount of gaging water used in the mix. Overgaging easily occurs with light weight or porous aggregates which absorb excess moisture.

The tested light weight castables were developed for gunniting and naturally are difficult to pour into forms because they are not designed to flow easy. In order to facilitate pouring of homogenious test specimens greater than recommended water ratios had to be used. This, together with internal stresses caused by the high shrinkage rate may have been contributing factors to the more pronounced failures of calcium silicate cements in light weight castables.

Besides reactions of the free lime portland type cements at temperatures above 1300 F can be subject to mineral inversions which result in volume

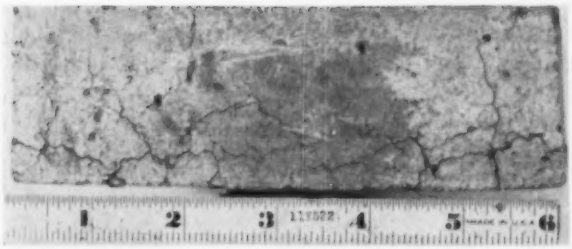


FIGURE 4—Example of carbon disintegration failure of a medium weight castable after three cycles at 1800 F in illuminating gas atmosphere.

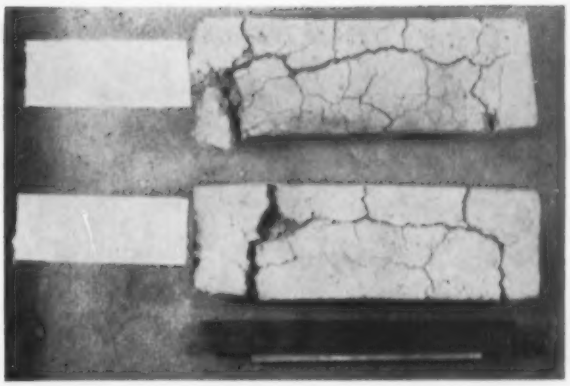


FIGURE 5—Example of carbon disintegration failure of a standard weight castable after two cycles at 1800 F in illuminating gas atmosphere.

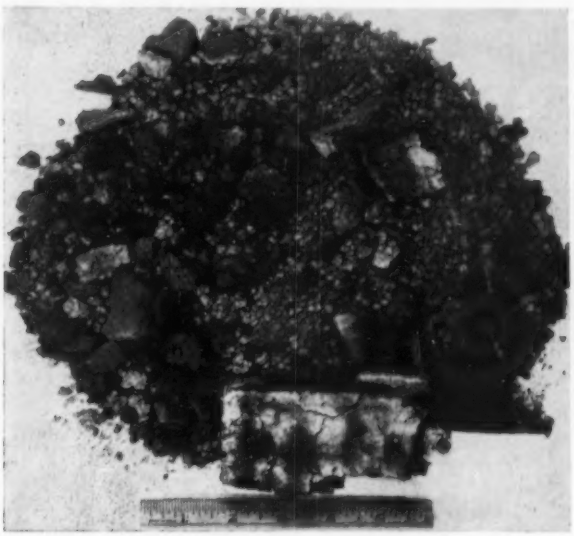


FIGURE 6—Example of carbon disintegration failure after 4 cycles at 1800 F in illuminating gas atmosphere. Material is identical to that of Figure No. 5.

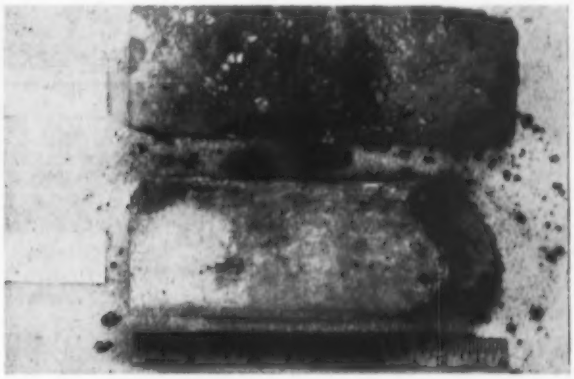


FIGURE 7—Example of carbon disintegration failure of an erosion resistant castable after 5 cycles at 1800 F in illuminating gas atmosphere.

changes which can develop disruptive forces.

Finally all castables containing calcium silicate cements with one exception, failed completely by fusion when vitrification set in between 2000-2250 F. The high percentage of silicates is responsible for this.

Specimens bonded with regular calcium aluminate cement consistently failed when cycled at 1800 F in illuminating gas atmosphere. Gas of the analysis shown in Table 2 was used.

Disintegration of samples obviously was caused by destructive internal carbon depositions around nuclei of iron particles. The attendant volume increase produces the disruptive force. Unfortunately also the rupture strength of castables is at a minimum around 1800 F because the original hydraulic bond is lost by dehydration while the temperature is still too low for an effective ceramic bond by vitrification. The relatively high iron content of regular calcium aluminate cement catalyzed the decomposition of the hydrocarbons CH_4 and C_2H_6 into C and H_2 because the H_2:CH_4 ratio of subject gas was less than the equilibrium mixture for 1800 F therefore carbon had to be deposited to reach a stable equilibrium. Actually from 1750 F upward hot gas leaving the furnace muffles contained a lot of soot, which kept plugging the burn off pipe. However, at 2000 F and above destructive carbon deposits were not observed, probably because vitrification set in and coated the iron particles with glassy silicates thus eliminating the catalytic surfaces (Figures 4, 5, 6 and 7).

The better known carbon disintegration resulting from the reaction

$$2\,CO \rightleftarrows CO_2 - C$$

which is most likely to occur around 1000 F was not observed. The latter requires a much higher percentage of CO than 9 percent as found in illuminating gas. Possibly more than 50 percent is necessary as reported by one observer.

Disruptive carbon depositions were not observed when calcium silicate cement was used. In this binder the iron content is lower and also sulphur compounds are added to facilitate quick setting. Sulphur is an effective catalyst poison, which may explain the different behavior.

Only iron free aluminous cement mixes proved to be stable over the whole temperature range in oxidizing

TABLE 2

CO_2	CO	O_2	H_2	CH_4	C_2H_6	N
2%	9.2%	3.7%	9%	26%	12%	Rest

as well as reducing atmosphere. They were not subject to any disruptive carbon depositions and also were free of the inherent shortcomings of calcium silicate cements.

Type of Failures

With regard to the type of failures as a result of excessive temperature, the following is noteworthy:

The atmosphere of environment oxidizing or reducing did not influence essentially the softening or fusion temperature, however, it seemed slightly higher in oxidizing atmosphere.

Castables with calcium silicate binder generally failed by fusing completely into a liquid when fired within a 100 F margin above the maximum recommended service temperature. This sudden and complete breakdown is significant. On the other side, all castables containing aluminous cement failed more gradually when overheated. In the latter case there was a progressive softening spread over a range of several hundred degrees, providing a greater margin of safety against runaway temperatures.

The unfired castables of the test can be divided colorwise in two groups. One type which is more or less white and another which comprises various shades of typical gray concrete colors.

The white mixes derive their color from their pure iron-free alumina binder or pure iron-free portland type cement. When fired up to the point of incipient fusion these castables did not change their color. Above this light brown spots appeared giving them resemblance to alumina fire brick.

The gray mixes underwent more pronounced color changes. Up to 1500 F or as long as some hydraulic bond existed, the basic gray or greenish-gray was retained, assuming only lighter shades above 200 F. From 1500 F up specimens changed to biscuit-like colors, growing more and more brown or reddish-brown until failure occurred. These permanent color changes seem rather characteristic. An effort was therefore made to record the individual colors by matching color snips. This color chart has possibilities to determine in the field the maximum temperature to which a certain castable liner has been exposed; especially when all other means of temperature recording have failed.

Conclusions—When selecting commercial refractory castables, careful consideration must be given to all possible service conditions. It is not enough to note the maximum service temperature. Cycle temperature variations during operation, type of atmosphere and expected frequency of shutdown with attendant cooling influence decisively the choice of a castable.

The information handed out by reputable manufacturers of commercial castables were found fairly correct, but incomplete. Therefore, appropriate tests are advisable whenever castables have to be specified for new service conditions. The unexpected disruptive carbon deposits on catalytic iron particles from the decomposition of CH_4 at 1750-1800 F proved this point.

The ASTM specifies an atmosphere of 100 percent CO for the standard distintegration test. An atmosphere of CO alone should be a rare occasion in any process. Indications are that a certain minimum percentage, possibly more than 50 percent of CO is required to produce such damage. More work is desirable to determine exactly the critical range of CO concentrations.

The maximum service temperature as recommended by reputable manufacturers of commercial castables is reliable. Materials with ratings up to 2000 F will not fail even if soaked at the maximum temperature. However, ratings from 2250-3000 F must be considered more or less as hot face temperatures.

Castables containing high early strength portland cement as hydraulic binder can be used without limitations up to 1300 F. Regarding service at higher temperatures it must be kept in mind that during subsequent cooling and shutdown periods some instability exists due to reaction of dehydrated lime with the surrounding atmosphere or to mineral inversions. Excessive hydration during application increases this instability. Portland cement mixes, however, offer good resistance against carbon disintegration.

Castables containing calcium aluminate cement combined with suitable aggregates possess temperature stability up to 2250 F. Service environment containing high percentage of CO (about 50 percent and more) and CH_4 will cause carbon distintegration in a temperature range of 900-1700 F. The reaction is catalyzed by the high iron content of the calcium aluminate cement.

Castables for hot face temperatures of 2500-3200 F require practically iron-free (less than 1 percent) calcium aluminate cement for reasons of temperature stability. These castables, if mixed with an equivalent inert aggregate possess also the greatest stability against various service environment.

If one would condense the results derived from this test program into one sentence, it might be stated:

In selecting a castable material for a vessel lining, check for substances in the castable which might be a catalyst for undesirable reactions or which react chemically with the service environment in a way to cause damage to the liner itself or to substances inside the contained equipment, for instance catalysts.

This paper was presented at the ASME Petroleum Division Conference, New Orleans, Sept. 25-28, 1955.

##

Meet the Authors

Vogrin

Heep

CHRISTIAN M. VOGRIN is a section engineer in the Piping division of The M. W. Kellogg Company. A graduate of the City College of New York, he has been with the Kellogg organization since 1942. Vogrin is a member of two ASA committees. He serves the Committee on Steel Flange and Flange Ratings, and the Committee on Pipe Flanges and Fittings.

HEINRICH HEEP, the first man to use the name, "Snorkel," was a consultant on U. S. and British submarine problems when he joined The M. W. Kellogg Company in 1952. Educated at the Technical University of Berlin and one time a research associate there, Heep was with Germany's H. Walter, K. G., during World War II. While heading that company's Submarine Development division, he made decisive contributions to the Snorkel design and was credited with naming the new device.

REVERE COPPER
ideal for distillation columns

These photographs show three distillation columns fabricated by American Copper & Brass Works, Cincinnati 2, Ohio, for a customer in a foreign country. They are made of Revere Copper Sheets and Circles. All told, 4608 pounds of copper were required. The columns will be used to distill high-proof alcohol, either beverage or industrial.

Longitudinal seams were welded. Flanges were produced by simply turning the metal over to the required dimension. Copper, you see, is extremely easy to work. In addition, it does not react with alcohol and a wide variety of other liquids and gases. Copper also can be quickly and economically welded by modern methods, and if you wish, the Revere Technical Advisory Service will be glad to show you how to do a fast and sound welding job on copper sheet and plate. See the nearest Revere Sales Office.

Two views of three copper distillation columns by American Copper & Brass Works, Cincinnati. The large holes will be closed by removable plates, for inspection and cleaning.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. Sales Offices in Principal Cities; Distributors Everywhere.

For more data on advertised products, use Readers' Service Cards, last page.

Shale-Oil Facility Planned

SHALE OIL is still trying to get a start in the world. At Rifle, Colo., the Bureau of Mines is studying safety in mining the oil-bearing material, while nearby Union Oil Company of California is building private industry's first pilot plant in the U. S. And now at Denver, a research institute has been hired to try out a Swedish process. For that story and a description of the process, see "Who's Building."

Keep Going to Page 187.

Twenty-five Equipment Items

TWO NEW LINES of general-purpose centrifugal pumps are among the 25 or so items of new equipment described in "What's New in Equipment" this month. Information on any of this equipment can be obtained by using the easy-to-handle "Reader's Service Card" on next to the last page of the magazine. In addition there are 13 items of Manufacturers' Literature which also can be requested on the "Service Card." **Keep Going to Page 258.**

Flow Information Released

ONE OF THE BOOKS reviewed this month is *A.G.A. Flow Constants,* a manual for orifices where flange taps are used. This book should be a help to the petroleum-refining industry, where accurate flow measurements require precise calculation of metering equipment. See "Reviewing New Books," for this and other reviews important to the industry.

Keep Going to Page 172.

Having Trouble with Crayfish?

IF YOUR TROUBLE is keeping crayfish out of dikes, learn how this was handled at one plant. If you are not having trouble with your dikes, read "How to Do It" anyway. This month's offering on crayfish may not be up to our usual standard of helpful hints, but it is certainly one of the most interesting hints we have run on to in a long time. **Keep Going to Page 166.**

Refiners Set Meetings

TECHNOLOGISTS, refiners and industry executive already are turning their attention to Montreal, in anticipation of a top-notch meeting scheduled for that quaint old town. For the program of the API Division of Refining's first Mid-Year Meeting to be held in Canada, see "What's Happening." The meeting will be headed by the division's vice president, E. B. McConnell, of The Standard Oil Company (Ohio).

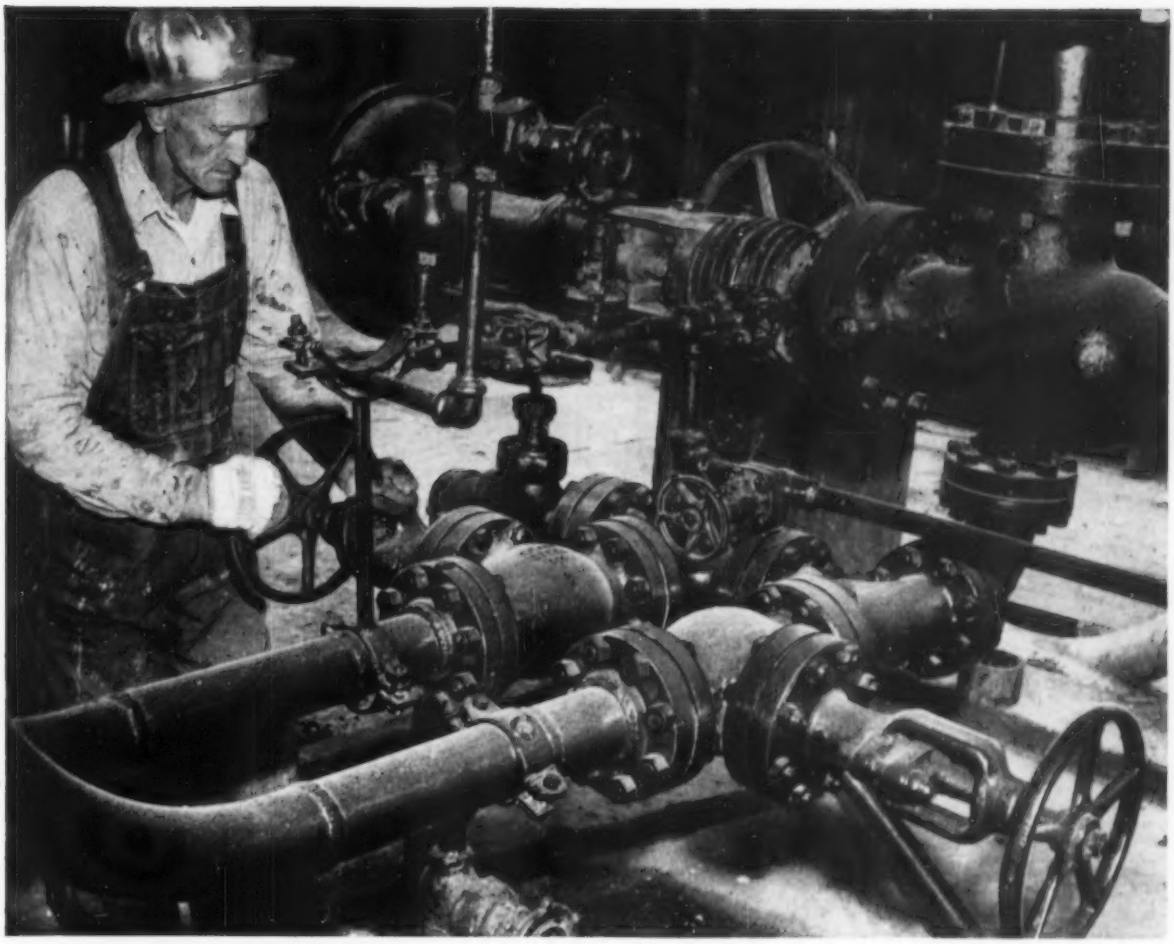
McConnell

Keep Going to Page 217.

New Recorder Explained

A REPORT on a new tool for studying engine combustion is one of the topics taken up in "Heard at Meetings" this month. Dealing with the Crank Angle-Time Recorder, it was given at the recent SAE meeting in Detroit.

Keep Going to Page 178.



They're saving with these Crane valves on 850° F. draw-off service

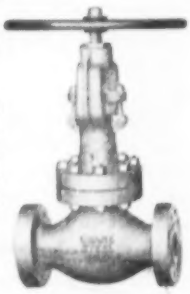
THE CASE HISTORY—What does it cost to keep a valve working? The answer can vary widely—as the DX-Sunray Oil Co. knows after long experience with Crane maintenance-saving valves.

For instance, take the 3-inch, 600-pound cast steel valves shown here. These No. 171X Crane globes were installed in 1945 on draw-off lines from reaction chamber. They handle oil at 850° F.

In 9 years' continuous service with frequent operation, these valves have cost no more than simple routine maintenance. They've shown no leakage, given no trouble of any kind. They're still as dependable as new.

Outwardly Crane valves look like many others. The difference that's important to you is mainly inside. It's in Crane's greater skill and care in casting steel—in developing Exelloy seating—in operating design—and in Crane's way of testing valves. That's why they give extra long, low-cost service.

Crane offers you complete selection in steel gate, globe, angle and check valves in all pressure classes—in sizes up to 24 inches.



For valuable help in specifying and ordering, call your local Crane Representative.

CRANE VALVES & FITTINGS

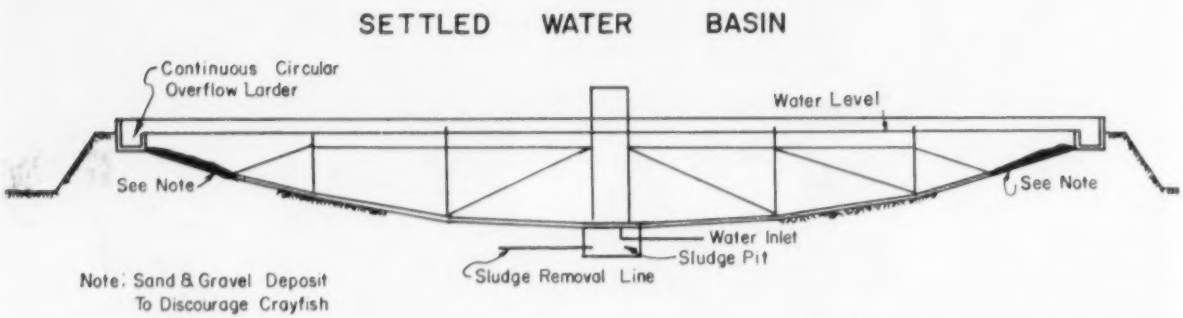
PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

For more data on advertised products, use Readers' Service Cards, last page.

How To Do It . . .

$10 is paid for each accepted idea. Mail to Editor, Petroleum REFINER, P. O. Box 2608, Houston 5, Texas.



Stop Crayfish Leaks in Your Dikes!

. . . Here's how practical experience was used to save money and downtime.

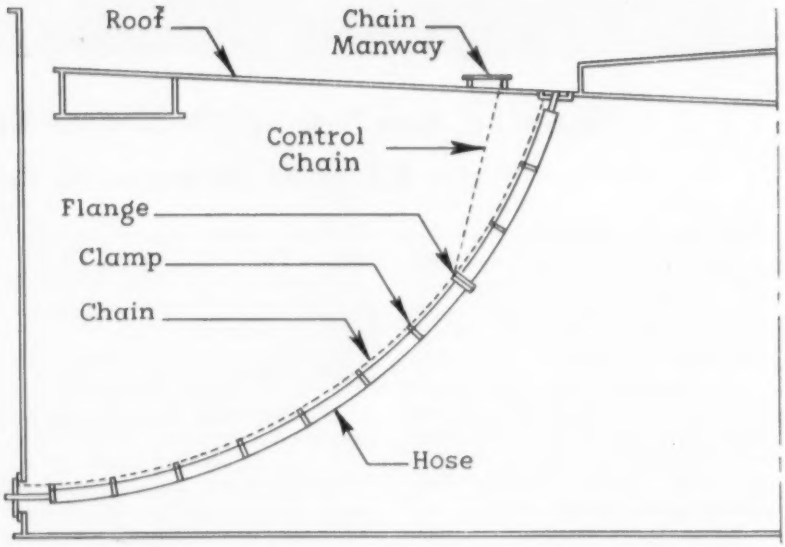
Soon after startup, leaks began to develop in the dikes at one installation. The first thought was that a porous soil condition was causing the leaks, and some consideration was given to installing bentonite clay or asphalt seal coat.

On careful inspection, however, the real trouble was found to be crayfish holes.

The holes were bored on the wet side almost through the dike. Thus water easily seeped through, and serious leaks were started. The real problem was to get rid of the crayfish, at least discourage them.

The answer came when someone recalled that crayfish do not bore into sand or gravel. The water level was lowered, and from two to four inches of sand and gravel was laid over the dike wall.

Sure enough, in a few days the leakage had slowed to a trickle. Today, after a year, there is no leakage.



Replace Drain Hose Without Cleaning Tank

Here is a good way to replace a drain hose without cleaning the tank. When you need to change a hose, try following this sequence of operations:

Lower the oil in the tank to about one foot. The flanged joint, where the two sections of hose are joined, is drawn up to the deck by the supplementary control chain, through the chain manway provided for this purpose.

Disconnect the two sections of hose and tie a length of rope from the deck through the chain manway to the end

Now — A Revolutionary NEW Steam Trap!

INSTALL IT — FORGET IT!

ACTUAL SIZE

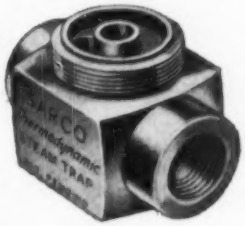
SO RUGGED **SO SIMPLE**

this steam trap practically eliminates maintenance

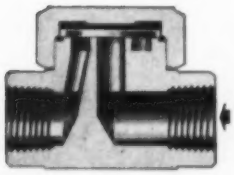
1. A CAP

2. A DISC

3. A BODY



That's all!



SIMPLICITY ITSELF!
No valve-closing mechanisms to wear or stick. No critical clearances to choke. No gaskets to leak. Only moving part a SOLID stainless steel disc.

Major advance in trap design!

Imagine a steam trap machined from a solid block of stainless steel. A trap with only 3 parts...cap, disc and body...and not even a valve-closing mechanism — the kinetic energy of steam closes the valve and ONLY the TD uses this new operating principle.

That's the revolutionary new Sarco type TD. It has only one moving part...a hardened SOLID stainless steel disc. And it is not affected by superheat, water-hammer, corrosive condensate. That's why we can say INSTALL IT—FORGET IT!

Use the SAME trap for 10-600 psi...for light or heavy loads ...without seat or valve change or other adjustments. Closes tight on no load—no steam waste.

Ask for a 60 day trial installation of Sarco TD trap and strainer...write for bulletin 257. Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

A100-B

SARCO

Only Sarco Makes All 5 Types

That's why Sarco can give impartial advice on proper steam trap selection.

For more data on advertised products, use Readers' Service Cards, last page.

COOPER ALLOY

CORPORATION BRIEFS

• Edited by GEORGE BLACK

AKH #3 NOW AVAILABLE

How to maintain close dimensional accuracy, fine interior and exterior finish and uniform soundness in the casting of a 1¼ lb. stainless steel instrument housing is told in the latest case history in the Cooper Alloy Advanced Know-How series. Ask for AKH #3 and get the full story on the use of shell mold and shell cores in the production of one of those "impossible" castings.

BUNA N FITTINGS

Vanton's line of Buna N and natural hard rubber fittings is described in a newly revised four-page condensed catalog. Diagrams, dimensions, and application data are included. Ask for Bulletin BN.

INQUIRIES AT ALL TIME HIGH

The demand for technical literature of value is on the increase. Our librarian reports more than 20,000 individual pieces of literature requested during the past twelve months, and we're glad to know that we are serving the needs of so many plant operating and purchasing people. For a quick glance at the most recent publications available on request, write for Technical Literature Folder TL56.

OUR FACE IS STILL RED

We're still apologizing to the many people who have requested our deluxe stainless steel valve and fitting catalog. The demand not only exceeded our supply but our ability to process them as well. Even with daily overtime and Saturday work we still haven't caught up with requests . . . so please forgive us if you're one of those on the waiting line.

COOPER ALLOY
CORPORATION • HILLSIDE, N.J.

How to Do It . . .

of each section. Then by unbolting the flange connection at the deck and shell, each section of hose can be withdrawn.

Replace the support chain in the new hose. The two ropes, which had been attached to the ends of the hose sections where they were joined together, are attached at the same points on the replacement hose sections. The two new sections can be pulled into place by hauling up on these ropes.

Secure the deck and shell connections, flange the end sections of hose together, attach the control chain, and disconnect the two ropes. The floating roof is then ready to go back into service.

Safety Lock-Out Control Board May Prove Useful

Standard practice requires that mechanics be assigned individual locks for use when working on electrically controlled equipment. Each mechanic has his name and number engraved on the lock assigned to him.

In addition to this, safety lock boards are installed which accomplish a two-fold purpose: (1) The foreman can tell at a glance if an employee has taken his lock to a job requiring its use. (2) A check at the close of the day shows whether or not all locks have been returned.

Install Welding Tip Racks On Shop-Made Tank Dolly

When welders do a variety of jobs and need different cutting and welding tips, it sometimes is difficult to keep the extra tips clean and undamaged.

Install a rack in a shop-built tank dolly made of scrap pieces to hold

Gary STAINLESS STEEL WELDED GRATING

Particularly suited for conditions such as in the chemical and petroleum industries. Available in many types of stainless from Gary Type GW-75A (¾" x ⅛" main bar, ¼" hexagonal cross bar) to Type SGW-225 (2¼" x 3/16" main bar, 3/16" hexagonal cross bar). Send today for full details.

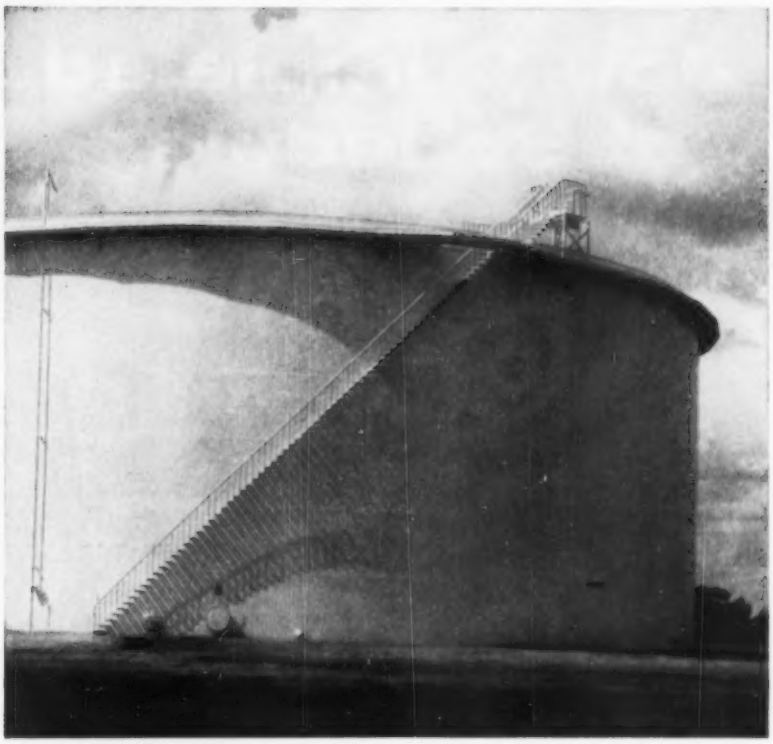
Write for Catalog PR-26

Standard Steel Spring Division

ROCKWELL SPRING AND AXLE CO.

4011 East Seventh Avenue • Gary, Indiana

For more data on advertised products, use Readers' Service Cards, last page.



The Sinclair Pipe Line Company and Rockwood have developed a new integrated fire protection system that is actually built into this Sinclair Pipe Line Company floating roof tank at Humboldt, Kansas.

A new approach to floating roof tank protection

Now for the first time, an integral Foam-making and Foam-distribution system that brings truly modern fire protection to floating roof tanks.

Tank fires usually occur in tanks of the floating roof type. Lightning is the chief cause of these fires.

Portable Foam hose lines could put out these vapor seal fires — *if* there was sufficient manpower — *if* the Foam lines could be placed into operation soon enough — *if* the hose streams could be brought close enough to the fire. There were too many "ifs" to this system. There must be a better way — and there was!

Rockwood, working in conjunction with Sinclair Pipe Line Company, developed a unique and practical method —

A compact, more economical, more effective integrated system that is actually built into the tank! This system insures speedy Foam delivery and distribution in the critical vapor seal space between the tank wall and the floating roof.

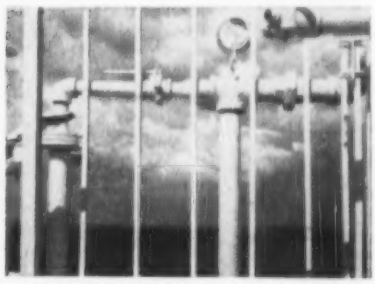
Here's an entirely new approach to protecting floating roof tanks. It not only minimizes losses, but permits the fire to be put out by one man if necessary and increases the safety of fire fighting personnel. Write for full information on this unique fire fighting idea!

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

Distributors in all principal cities

Tee-shaped Distributor Nozzle discharging Foam from Rockwood Foam Maker Unit into vapor seal space between floating roof and tank wall.



This stair platform at top of tank shows the Foam Hydrant (top right) and Rockwood Foam Maker Unit (center) which is located so as to deliver Foam to roof area below stair platform.

Gasoline engine driven fire pump, Foam liquid storage tank and Rockwood around-the-pump Foam proportioning system at Sinclair's Humboldt Station. This unit has a Rockwood "L" type Metering Valve and Rockwood "B" proportioner.

ROCKWOOD SPRINKLER COMPANY
Portable Fire Protection Division
1089 Harlow Street
Worcester 5, Mass.

Please send me full information on the Rockwood Integral Foam-making and distribution system.

Name.....

Title.....

Company.....

Street.....

City..... Zone.. State.....

For more data on advertised products, use Readers' Service Cards, last page.

HIGH YIELDS—LOW COSTS with Kellogg Steam-Methane Reforming

Helping to meet increasing demands for petrochemicals, the Sohio Chemical Company's new anhydrous ammonia plant at Lima, Ohio will have a capacity of 300 tons per day. Engineered to get optimum efficiency from refinery gas and natural gas, and constructed well ahead of schedule, this multi-million dollar project was The M. W. Kellogg Company's responsibility from start to finish.

The M. W. Kellogg Company is privileged to participate in the current expansion program of the Sohio Chemical Company, which provides further evidence of the efficiency of Kellogg's steam-methane reforming process and its unique quench-type reactor. This process is one of four which M. W. Kellogg offers ammonia producers for meeting various local operating conditions. Some idea of the flexibility of ammonia plant design permitted by these four processes, with specific details of each, may be obtained by writing for M. W. Kellogg's 12-page, illustrated booklet, "Synthetic Ammonia—Four Basic Plant Types."

M KELLOGG W

PETROCHEMICAL PROCESSES AND PLANTS

CHEMICAL PROCESS DIVISION

THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N. Y.

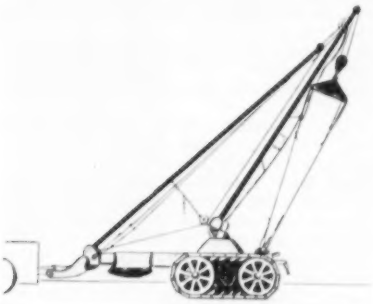
The Canadian Kellogg Company, Limited, Toronto • Kellogg International Corporation, London

SUBSIDIARIES OF PULLMAN INCORPORATED

How to Do It...

these spare tips. Weld two strips of metal across the back of the dolly from the extended sides. Burn holes through these strips to hold the tips. Keep various sizes and angles of welding tips in the top rack and cutting tips in the bottom rack.

Use a chain with attached turnbuckle to hold the racks to the tanks. Use construction reinforcing metal brackets to hold the hoses when not in use.



Gin Pole on Half Track Handles Heavy Loads

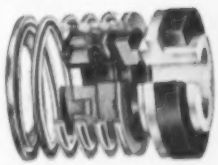
Heavy equipment may be moved safely about the job with the half-track boom assembly shown here. The rig is designed not only to give a light truck a mechanical advantage large enough to handle big loads, but also to provide height necessary to carry long lengths of pipe.

A heavy steel spreader bar attached to the gin-pole block prevents excessive tension on the slings.

The entire assembly is mounted on salvaged army half tracks. A strongback made of steel plate and hog rod reinforces the gin pole.

3 JOHN CRANE Shaft SEALS
for lifetime performance in any petroleum or petrochemical service

TYPES 1 and 2
Synthetic Rubber Bellows • For Low Pressure Service



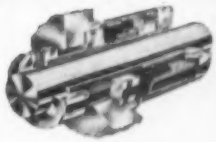
Services: gasoline, diesel fuel, fuel oil, crude oil, butane, propane, ethane and similar products non-injurious to synthetic rubber.

Pressures: to 200 psi.

Temperatures: −40°F to +212°F.

Construction Data: Factory assembled. Self-adjusting sealing head. Lapped faces positively prevent leakage. Low spring pressure for minimum wear. *Available in balanced construction for pressures to 550 psi.*

TYPE 8B
Packaged Type Seal • For High Pressure Service



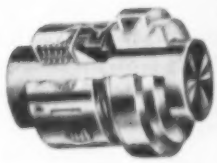
Services: Same as Types 1 and 2.

Pressures: to 1200 psi.

Temperatures: −40°F to +250°F.

Construction Data: Heavy duty. Hydraulically balanced to handle high pressures. Single-unit package for easy installation.

TYPE 9
Sealing Members Made of Teflon* • Engineered for service conditions that do not permit use of rubber



Services: alkyl benzine, benzine, creosote, silicone oil, some petroleum derivatives, and all known corrosives.

Pressures: to 150 psi. (balanced construction to 750 psi.)

Temperatures: −120°F. to +500°F.

Construction Data: Furnished in the metallurgical specification best suited to the particular service. Flexible wedge ring and sealing ring molded from chemically inert Teflon.

Contact "John Crane" for the shaft seal best suited to your requirements. Request bulletin giving full information on "John Crane's" complete line of mechanical seals.

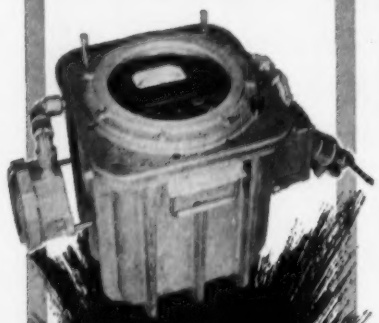
Crane Packing Co., 6420 Oakton St., Morton Grove, Ill., (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

*DuPont trademark

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

For more data on advertised products, use Readers' Service Cards, last page.

Portable analyzer
for hazardous locations...



DAVIS PORTABLE EXPLOSION-PROOF COMBUSTIBLE GAS ALARM SYSTEM

A completely self-contained, precision instrument that can be set up quickly in or near hazardous locations. Has visual and audible "high gas" signals; continuous sampling by motor-driven pump; large, easy-to-read meter; "trouble-indicating" circuit. Easy to use, easy to maintain. Dimensions: 20" x 14" x 16"

Send for Bulletin 11-35

INSTRUMENT DAVIS DIVISION

DAVIS INSTRUMENTS
Division of
Davis Emergency Equipment Co., Inc.
164 Halleck Street, Newark 4, N. J.

Reviewing New Books . . .

A. G. A. Flow Constants, prepared for The Foxboro Company. This new manual for orifices where flange taps are used will speed the computation of orifice sizes, coefficients and flows. It is expected to save engineering time in the oil, gas and chemical industries where accurate flow measurements require precise calculation of metering equipment.

Compiled as a supplement to "Principles and Practice of Flow Meter Engineering" by L. K. Spink, the manual contains a total of 77,811 separate flow calculations evaluated to six figures. These include values of S for an infinite Reynolds number, values of E, and values of K, derived from the equations developed by Dr. Buckingham and used by A.G.A. and A.S.M.E. Figures are presented in d/D steps of 0.001 from 0.100 to 0.800 for each of 37 line sizes from 1.535" I.D. to 29.25" I.D.

The 111 pages of tables were photographically reproduced from calculations made by automatic computer machines, thus eliminating the possibility of typographical errors. Spot checks of calculations were made to rule out possibilities of errors in the operation of the computer.

Use of the tables will save time in computing odd orifice sizes, odd pipe sizes, round-number coefficients and orifices for direct-reading gas meters where the line pressure is held constant.

(The Foxboro Company, Foxboro, Mass., 111 pages, $10.)

Determination of Shear Stability of Non-Newtonian Liquids, prepared by N. D. Lawson—This publication will be of value to those concerned with development or use of polymer liquids and of mechanical devices in which those liquids are used. It describes several test procedures which are capable of giving comparable results.

It reports the data from a cooperative effort to develop a suitable test method for measuring shear stability of Non-Newtonian liquids. The test methods studied included sonic vibrators, sharp-edged orifices, flow through a diesel fuel injector, and a pressure release valve.

The two test liquids were made by blending polyalkyl methacrylate polymers with a light petroleum base oil. Since the shear stability equipment subjected the oils to different rates of shear or severity, a direct comparison of the methods is not obvious.

However, a comparison under conditions of equal severity shows that they do give identical results, leading to the conclusion that various test procedures could be used provided a reference liquid is used to calibrate the equipment.

(American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 12 pages, 75 cents.)

Mass-Transfer Operations, by **Robert E. Treybal.** This book introduces the general features of diffusion and the techniques used in the industrial application of mass-transfer operations.

It not only presents a background in theoretical material, but covers the principles of equipment design, equipment operation and the fields of application for the following unit operations: humidification and dehumidification, gas absorption, distillation, liquid extraction, adsorption of gases and liquids, ion exchange, drying, leaching, and briefer discussions of dialysis, gaseous diffusion, atmolysis or mass diffusion and thermal diffusion.

This is the first completely integrated treatment of these unit operations. It will serve as an introduction to the increasingly complex periodical literature.

(McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, 666 pages, $9.50. For sale by Gulf Publishing Company, P. O. Box 2608, Houston.)

Salt and Water, Power and People, by Robert E. Thomas. This book gives a short history of Hooker Electrochemical Company. It discusses a few of the events and people associated with the past fifty years of Hooker's growth and progress.

(Hooker Electrochemical Company, Niagara Falls, N. Y., 109 pages.)

Tables of Thermal Properties of Gas, by Joseph Hilsenrath, C. W. Beckett, W. S. Benedict, Lila Fano, H. J. Hoge, J. F. Masi, R. L. Nuttall, Y. S. Touloukian and H. W. Woolley. This collection of tables covers the thermodynamics and transport properties of air, argon, carbon dioxide, carbon monoxide, hydrogen, nitrogen, oxygen and steam.

The properties of compressibility factor, density, entropy, enthalpy, specific heat, specific-heat ratio and sound velocity are tabulated for the real gas at pressures up to 100 atmospheres and to temperatures of 600 K for hydrogen, 1500 K for carbon dioxide, 850 K for steam and 3000 K for the remainder. The ideal-gas thermodynamic functions are tabulated uniformly to 5000 K.

Also tabulated are the vapor pressures and transport properties, thermal conductivity, viscosity, and Prandtl number. These were fitted either semi-theoretically or empirically to the experimental values and are tabulated over the range of the available experimental data.

Comparisons of the tabulated values with the existing experimental data are shown in deviation plots which exhibit the range and distribution of the experimental data as well as their agreement with the tabulated values.

(Government Printing Office, Washington 25, D. C., 478 pages, $3.75.)

Analytical Procedures for Synthetic Lubricants, a report on Air Force research. This report presents a relatively simple schematic procedure for the analysis of synthetic lubricants and additives and a new paper chromatographic method for the separation and identification of antioxidants.

While these new techniques for identifying lubricant components do not in all cases have the accuracy of optical and other standard methods of analysis, they are relatively quick and easy to apply in field analyses, have good reproducibility, good qualitative selectivity and quantitative accuracy.

Based on a year's research by Denver Research Institute for Wright Air Development Center, the report traces the steps

Tuffy® SLING NEWS

Vol. 1 Published Monthly in Leading American Trade Magazines by Union Wire Rope Corp. No. 4

HOW NEW FERRULE WORKS IS SHOWN IN FREE SLING BOOK

Ferrule Story, Facts on Fittings and Slings In Useful New Edition

This new and enlarged edition of the Tuffy Sling Handbook is an absolute "must" for plant and safety engineers, purchasing agents and shop foremen—everyone who uses, buys, or supervises work with slings. We distributed more than 85,000 copies of the first edition, and the demand for this new, completely revised edition is going to be even greater.

Featured in our new Sling Handbook is the new Tuffy streamlined metal ferrule pressed on the tucked eye splice. This new Tuffy Sling Handbook lists nearly a dozen new fittings—sling bridles, slip-on thimbles, safety hooks, sling saddles, horizontal clamps, and many others. It tells you all about the enlarged line of factory-fitted Tuffy Slings. It contains a complete rigger's manual, proof-tested rated working loads and specifications on all Tuffy Slings.

It's Yours Free, but our supply is going fast. So mail the coupon now for your copy of this valuable Tuffy Sling Handbook.

SEE DISTRIBUTOR FOR TUFFY SLINGS AND HOIST LINES

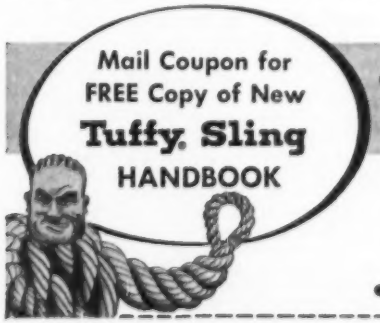
He can save you the time and trouble of carrying a full inventory. Tell him your normal requirements and he will keep matching stock of Tuffy Slings and Tuffy Hoist lines for fast delivery. Your Tuffy distributor can supply longer sling service life—bigger value for your money.

New Tuffy Ferrule Exclusive Feature at No Extra Cost

Union Wire Rope developed the new Tuffy Sling ferrule to make Tuffy Slings easier, safer, and faster to handle. It took extensive research and proof testing to improve upon the full length hand splicing of Tuffy Sling eyes which have withstood the test of time. Now equal or greater strength is attained with ferrule splice and the hazards of protruding tuck terminals are eliminated. Yet it costs you nothing extra for this exclusive feature.

Strength of Tuffy Fabric Now Equaled in Splice

First, the 9-part machine braided Tuffy Fabric of the sling eye is tuck-spliced together. Then the new Tuffy steel ferrule is slipped around the splice. Under terrific pressure, the metal of the ferrule (see cross section of splice and ferrule above) virtually flows into the interstices of the machine braided fabric. Every Tuffy sling is given strength at the eye splice equal to the superior strength of the machine braided fabric. The swaging of the ferrule at the ends makes them smooth, so they can't injure hands or catch on loads.



union Wire Rope corporation

Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand.

2284 Manchester Avenue, Kansas City 26, Missouri

MY NAME _____ TITLE _____

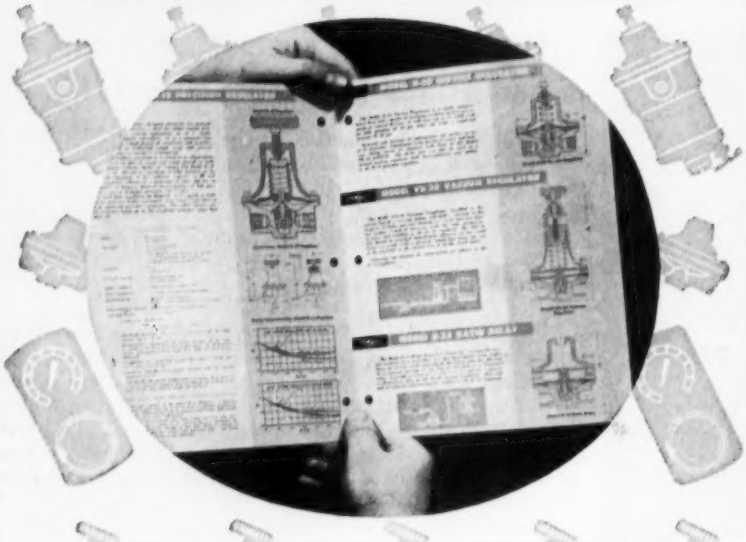
COMPANY NAME _____

ADDRESS _____

CITY _____ ZONE ____ STATE _____ 15

For more data on advertised products, use Readers' Service Cards, last page.

ONLY CONOFLOW
OFFERS A COMPLETE SELECTION
of
PNEUMATIC REGULATORS



√ MODEL H-10 PRECISION REGULATOR
√ MODEL PH-10 REMOTE CONTROL PANEL
√ MODEL FH-20 FILTER-REGULATOR
√ MODEL F-1 AIR FILTER
√ MODEL H-20 SERVICE REGULATOR
√ MODEL VH-20 VACUUM REGULATOR
√ MODEL H-22 RATIO RELAY
√ MODEL DH-21 PURGE ASSEMBLIES

Only Conoflow stocks a *complete line* of precision-made, low cost, pneumatic regulators which meet all the rigid requirements of the instrument industry.

Conoflow regulators are used to maintain a filtered and regulated supply to pneumatic instruments . . . on test stands . . . for a variety of applications on packaging machines . . . on remote manual control panels . . . for purging lines on differential manometers . . . in bleed systems . . . for manual to automatic by-pass service, etc., etc.

Write today for Bulletin H-2 illustrating and describing the Conoflow Series "H" regulator line. It's chock-full of cross section and dimension drawings — performance characteristics and applications. It will be mailed to you promptly, without obligation.

CC601

Cono-Controls

CONOFLOW CORPORATION
FOREMOST MANUFACTURER OF FINAL CONTROL ELEMENTS
2100 Arch Street, Philadelphia 3, Pa.
SALES-ENGINEERING REPRESENTATIVES IN PRINCIPAL CITIES
Subsidiary of Walworth Company

New Books . . .

in the schematic analysis of greases with mineral and synthetic base-oils, inorganic and organic gelling agents, soap and urea type thickeners and antioxidants. Charts and diagrams detailing the processes are given, with numerous photographs. A 30-page bibliography is included.

(Office of Technical Services, Department of Commerce, Washington 25, 223 pages, $5.75.)

Design of Piping Systems, by members of the Engineering department of The M. W. Kellogg Company. This book is intended to supplement code rules and other readily available information with specific mechanical design approaches for entire piping systems as well as their individual components. It provides a background of information which will create understanding, competent application of analytical results, and the exercise of good judgment in handling the many special situations which must be faced on critical piping.

(John Wiley & Sons, Inc., 440 40th Avenue, New York 16, 365 pages, $15.)

Heat Insulation, prepared by William Kenyon and Sons, Limited. A discussion is given of the three mechanism of heat transmission: conduction, convection, and radiation. A group of nomographs also are presented which show the effect of insulation on the rate of heat transmission.

The various materials of insulation are discussed and the economics of their use are considered. The best method of practical application for several configurations is emphasised by illustrations.

The many charts, nomographs, diagrams, and pictures makes this a useful book for those interested in heat insulation.

(William Kenyon & Sons, Ltd., Dukinfield, Cheshire, England, 130 pages.)

Reviews of Petroleum Technology, Vol. 14 (Covering 1952-1954), by E. B. Evans, D. L. Samuel and George Sell. This is a readable account of the recent progress in the petroleum industry. It covers geology, drilling, refining, and transportation. Even the allied fields of petroleum chemistry, crude evaluation, and synthetic fuels are included in the discussions.

The style of this volume differs from its predecessors in order to review on a broader basis and to be more consistent with the actual trends in science and technology. The book is heavily documented so that academic subjects do not lengthen the discussions.

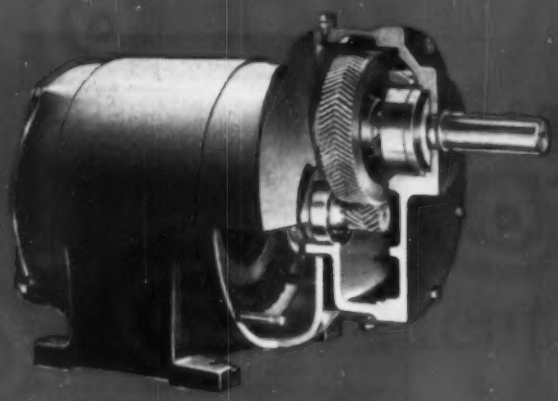
(The Institute of Petroleum, 26, Portland Place, London, W. I., 220 pages.)

Distillation in Practice, edited by **Charles H. Nielsen.** This book is based on the second "Experience in Industry" symposium jointly sponsored by the Philadelphia-Wilmington Section of the AIChE and the University of Pennsylvania.

It covers the most recent developments in the evolution of distilling techniques, column design, techniques of petroleum fractionation, instrumentation, operation of distillation equipment, and commercial aspects of vacuum distillation.

The contributors are among the country's foremost authorities in the field of distillation and bring to this book the benefit of their wide knowledge and practical

For more data on advertised products, use Readers' Service Cards, last page.



SINGLE REDUCTION
Parallel Shaft Type

MASTER -1st Choice for GEARMOTORS

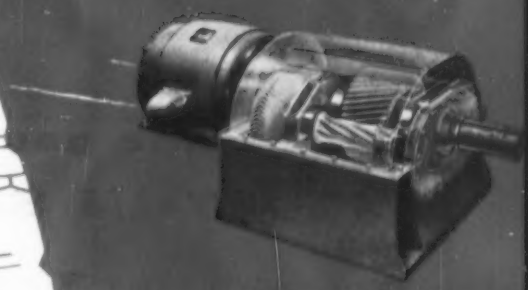
Because...

... With five types of parallel and right angle Gearmotors, Master has the flexibility and choice of design you need for selected output speeds.

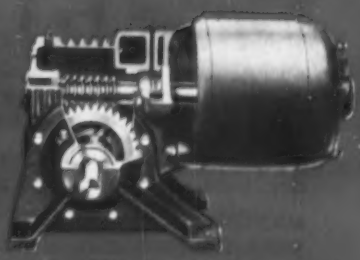
... With electric motor and gears combined into a compact, integral power unit, you reduce costs and increase efficiency through elimination of belts, couplings, chains, sprockets, external bearings or separate reducers.

... Available in sizes from 1/8 to 125 H.P. You can integrate with the gearmotor electric brakes—3 types of variable speed units and fluid drive in any combination.

... And that's why more gearmotors carry the Master name than all other makes combined. Write on your business letterhead for details.



DOUBLE REDUCTION
Parallel Shaft Type



SINGLE REDUCTION
Right Angle Shaft Type

THE MASTER ELECTRIC COMPANY
Dayton 1, Ohio

the **NEW**

USG **SOLFRUNT®**

(SOLID FRONT CONSTRUCTION)

the gauge with

BUILT-IN SAFETY!

There's safety with the new USG Solfrunt Gauge . . . behind the face is a solid metal wall! In the event of a Bourdon tube rupture, pressure is released through the large rubber blowout back. The case is of aluminum.

Like USG's Supergauge . . . with proper application . . . the Solfrunt is built to last a lifetime.

ARC-LOC MOVEMENT—Rugged beyond compare . . . broad generated gear faces, deep stainless steel bushings. Calibration adjustments from rear by merely removing blowout back.

SEGMENT—Stainless steel, with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . maintains accurate pitch diameter . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions.

LEGEND ON DIAL—gives complete description of socket, Bourdon tube, and movement material for ready identification.

MICROMETER ADJUSTABLE SELF-LOCKING POINTER—permits accurate repositioning of pointer.

Solfrunt Gauges available in 4½", 6" and 8½" sizes. For complete information on case styles, materials of construction and connections, write for Publication 1819.

USG **UNITED STATES GAUGE**

Gauge Headquarters FOR OVER 50 YEARS

UNITED STATES GAUGE
Division of American Machine and Metals, Inc., 104 Clymer Avenue, Sellersville, Pa.

New Books . . .

working experience. Students and particularly young practicing engineers throughout the process industries will welcome the book for its sound, basic information and as a stimulant for new ideas.

(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, $3, 133 pages.)

The Mexican Petroleum Industry, 1938-1950, by **J. Richard Powell.** This study deals with both the economic and the social terms in which success or failure of expropriation must be measured.

It first traces the development of Mexico from a country of enormous feudal landholdings to one of halting industrialization, and describes the strong feelings among Mexicans that theirs was a semi-colonial country, doomed to backwardness until it achieved economic independence and freedom from economic imperialism.

(University of California Press, Berkeley 4, Calif., 269 pages, $4.)

Construction Planning, Equipment, and Methods, by **R. L. Peurifoy.** Among the special topics covered in this work are:

- Construction stages and construction layout; keeping records of equipment performance, material costs, and labor costs; engineering fundamentals as they apply to construction; selection of the most suitable types of earth moving equipment; and reducing the cost of excavating and transporting earth.
- Illustrative examples, tables, illustrations, and problems are generously supplied throughout.
- Although the author treats the subject on an engineering basis, beyond the purely vocational level, the discussions can be understood by persons with vocational training.

(McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, 533 pages, $8.50.)

Recommended Practice for the Design and Construction of Pressure-Relieving Systems in Refineries. This publication is the result of a ten-year study to establish a sound engineering basis for such systems.

Reporting the findings of the Division of Refining's Subcommittee on Pressure-Relieving Systems, defines terms relating to pressure-relieving devices and their performance; describes construction and operation of relief valves, conventional and balanced safety valves, and (briefly) rupture disks; and gives relief capacities required for various operation difficulties which cause pressure accumulations.

It sets forth the usual causes and effects on wetted vessel surfaces of accidental fires outside of vessels; discusses the calculation of relief requirements for pressure vessels exposed to open fires; and states findings on protection of vesels from fire damage caused by local overheating on an unwetted surface by depressuring, insulation, earth-covered storage, water cooling, or drainage.

The publication also goes into the design of relief manifolds, and disposal methods for discharges from relief and depressuring systems.

(American Petroleum Institute, 50 West 50th Street New York 20, $1.50.)

For more data on advertised products, use Readers' Service Cards, last page.

New Rokide* Coatings Resist Heat and Abrasion

Rokide spray coatings help solve many high temperature and wear problems

WITH the rapid increase in modern high temperature applications there has been a corresponding increase in demands for resistant materials. Norton ROKIDE spray coatings are meeting such demands with great success. These hard, adherent crystalline refractory oxides offer many important advantages. For example:

They are both thermally and electrically insulating . . . Their hardness, chemical inertness and stability in combustion temperatures provide high resistance to excessive heat, abrasion, erosion and corrosion. Their high melting points and low thermal conductivities reduce the temperatures of the underlying materials and permit higher operating temperatures.

ROKIDE Coatings vs. Stainless Steel

Analyses of Norton ROKIDE spray coatings and of stainless steel reveal interesting comparisons. While less dense than the bare steel, the ROKIDE coatings are very much harder, have considerably higher melting points and are very much lower in thermal conductivity and thermal expansion.

Proof

There are three Norton ROKIDE coatings: ROKIDE "A" aluminum oxide, ROKIDE "ZS" zirconium silicate and ROKIDE "Z" stabilized zirconia. Thoroughly proved in such critical applications as reaction motors, as well as in AEC projects, the value of these coatings to a broad range of more conventional applications is obvious.

Applications

The versatility and adaptability of ROKIDE coatings are evident in the following list of applications, actual and suggested:

Baffle plates . . . bearing surfaces . . . mechanical seals . . . feed rolls . . . metal treads . . . thermal barriers . . . reflection coatings . . . coatings for exhaust ports, duct linings, ladles and crucibles . . . insulation for copper busbars, circuit breaker components, thermocouple wires and tubes, large and small electronic equipment . . . protection for nozzles, valve plugs, piston heads, pump shafts, gas turbine parts, etc.

Although ROKIDE coatings are most commonly applied to metals they are effective on other materials, such as ceramics and certain plastics. Thicknesses of the coatings generally range from .005″ to .05″.

Other Norton Electric Furnace Materials

are products made of CRYSTOLON* silicon carbide (including ROKIDE "C" coating for graphite parts and CRYSTOLON "N" monolithic shapes), ALUNDUM* fused alumina, MAGNORITE* magnesium oxide, NORBIDE* boron carbide and Fused Stabilized Zirconia. These high-melting materials are also the basic ingredients of the famous Norton Rx's — refractories *engineered and prescribed* for the widest range of uses.

For more detailed information on ROKIDE coatings, use the coupon.

ROKIDE Spray Coatings are applied in a molten state by means of a metalizing type spray gun. The oxide is fed into the gun in rod form at a carefully controlled rate. The coatings can be applied to parts of any size and to all shapes accessible to the spray gun equipment.

NORTON
REFRACTORIES
Engineered... Rx... Prescribed
Making better products... to make your products better

*Trade-Marks

NORTON COMPANY, *Refractories Division*
461 New Bond Street, Worcester 6, Massachusetts
Please send me further facts on ROKIDE coatings.

Name..... *Company*.....
Street.....
City..... *Zone*..... *State*.....

For more data on advertised products, use Readers' Service Cards, last page

REDUCE THE CHANCE OF USING THE WRONG VALVE LUBRICANT

ELIMINATE LARGE WAREHOUSE STOCKS

ONLY **4**

DESCO

PLUG VALVE

LUBRICANTS

ARE ALL YOU NEED

no matter what passes thru your valves!

No matter what the fluid or its temperature, Desco Lubricants are guaranteed to STAY in your valves . . . and 4 types are all you need.

Desco Lubricants will not harden or coke-up because they are ALL lubricant and contain no inert material.

CONVENIENT STICKS OR BULK

Packed in clean, convenient sticks in 5 sizes for gun or jack screw. Also in 5-quart, 5-gallon, and 100 lb. bulk containers.

The Only Complete Plug Valve Lubrication Company

DELTA ENGINEERING SALES CO.

639 Aero Drive Shreveport, La.

Sales Offices in All Principal Cities

DELTA-DESCO

PLUG VALVE

LUBRICANTS

AND EQUIPMENT

LUBRICANTS FITTINGS GUNS LUBRICATORS

Heard at Meetings . . .

New Tool for Combustion Studies

The Crank Angle-Time Recorder, makes it easy to record engine-cycle time, during erratic combustion. This was the report of Ethyl Corporation's J. A. Warren and J. B. Hinkamp at the SAE meeting in Detroit.

Other combustion-research tools are available for timing regularly recurring events, such as spark-plug firing, flame travel, and knock. However, these methods have not proved completely satisfactory for timing random events, such as "wild ping".

Both recurrent and erratic events can be timed with a Crank Angle-Time Recorder. The researchers predict that recorder studies will provide information of interest to gasoline refiners and engine designers.

The new time recorder is a crankshaft-driven drum covered with a special paper upon which a dot is produced by an electrical spark each time the device is triggered by a combustion event. Event-detecting instruments are used to activate the recorder. The paper record shows the crank angle in the engine cycle for each surface ignition or other measured combustion event.

The recorder is used to determine flame fronts which result in knock, effects of additives and fuel octane number on surface ignition, resistance of various fuels to surface ignition and effects of several factors on normal flame movement.

Committee Week Set for ASTM

The American Society for Testing Materials will hold its 1956 Committee Week and spring meeting February 27 to March 2 at the Hotel Statler in Buffalo, N. Y. More than 250 ASTM technical committees and subcommittees will meet to discuss and review the year's work. This will be in preparation for the annual meeting in June.

The only non-technical event of the week will be a dinner and entertainment Tuesday evening, February 28. It will be sponsored by the Buffalo District Council.

An all-day symposium, Wednesday, sponsored by Committee B-8 on Electrodeposited Metallic Coatings, will discuss Properties, Tests and Performance of Electrodeposited Metallic Coatings. Eight papers will be presented by outstanding authorities in various fields.

This symposium is considered so important that it will be repeated during the second Pacific area meeting at Los Angeles, September 17-21.

Among the committees meeting will be: A-5 on Corrosion of Iron and Steel; A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys; B-3 on Corrosion of Non-Ferrous Metals and Alloys; B-8 on Electrodeposited Metallic Coatings; C-8 on Refractories; D-3 on Gaseous Fuels; D-11 on Rubber and Rubber-Like Materials; D-16 on Industrial Aromatic Hydrocarbons and Related Materials.

SAE Dramatizes Automation Kinks

A show-business technique was used to dramatize problems facing the automotive industry in the field of automation. The skit was staged at the SAE meeting in Detroit. The all-star cast were top executives in the automotive and aircraft industries.

The story concerned a mythical manufacturing company making a machine called "Helitrac"—a combination tractor, passenger car and airplane. The problem was to decide how much volume it takes to justify automation. Here's the story:

The executive vice-president of ABC, played by A. T. Colwell, vice-president of Thompson Products, Inc., calls a meeting of his manufacturing manager (L. I. Woolson, president of DeSoto); chief project engineer (E. N. Cole, Chevrolet's chief engineer); purchasing agent (E. J. McNamara, director of purchases at Pratt and Whitney Aircraft), and sales manager (C. L. Hecker, first vice-president of Oliver Corporation.

The topics discussed included where and how to automate and how future

For more data on advertised products, use Readers' Service Cards, last page.

IN CHEMICALS (*Soaps and Detergents*)

Count on Enjay for fast product turnover

You get fast turnover when you make a better product. And uniform, high quality Enjay chemicals help make *your* products better. The Enjay Company supplies a diversified line of petroleum chemicals to the surface coating, chemical and petroleum industries. Through the facilities of the *new Enjay Laboratories*, you can be assured of the best application of Enjay products in your industry. *Next* time, call Enjay for your chemical needs.

PETROLEUM
PARANOX
PARATONE
PARAFLOW
PARAPOID
PARADYNE
PARATAC
PETROHOL
Methyl Ethyl Ketone
Dewaxing Aid
Ethyl Ether
Isopropyl Ether
Reference Fuels

RUBBER
ENJAY BUTYL
VISTANEX

SURFACE COATING
PETROHOL 91
PETROHOL 95
PETROHOL 99
JAYSOL
Secondary Butyl Alcohol
Secondary Butyl Acetate
Isopropyl Acetate
Acetone
Methyl Ethyl Ketone
Dicyclopentadiene
Ethyl Ether
Isopropyl Ether
Naphthenic Acids
Iso-Octyl Alcohol
Decyl Alcohol
Denatured Ethyl Alcohol

CHEMICAL
PETROHOL 91
PETROHOL 95
PETROHOL 99
JAYSOL
Iso-Octyl Alcohol
Decyl Alcohol
Denatured Ethyl Alcohol
Tridecyl Alcohol
Dicyclopentadiene
Isoprene
Butadiene
Ethyl Ether
Isopropyl Ether
Tetrapropylene
Tripropylene
Aromatic Tars
Benzene
Acetone
Methyl Ethyl Ketone

ENJAY

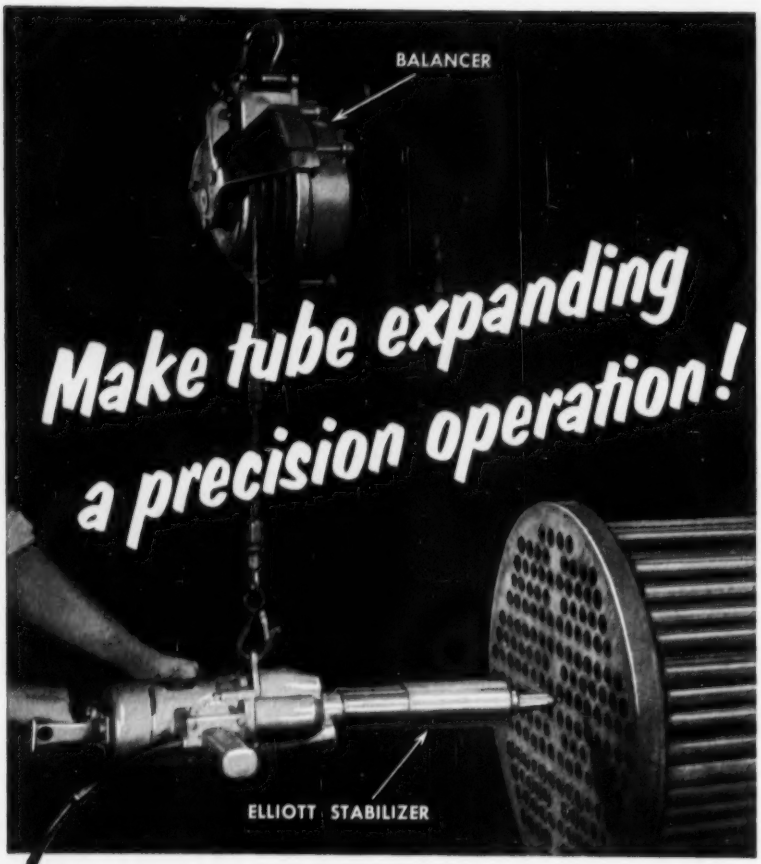
36 *successful years of leadership in serving industry*

Enjay Company, Inc. • 15 West 51st Street, New York 19, N.Y.
Other Offices: Akron • Boston • Chicago • Tulsa

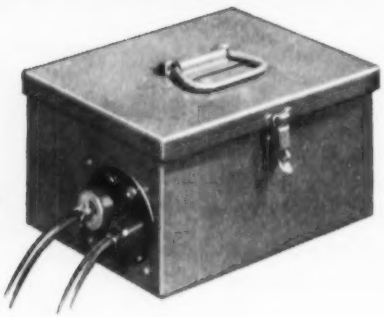
IN SURFACE COATINGS (*Paint, Varnish and Lacquer*)

IN PETROLEUM (*Lubricants and Gasoline Additives*)

For more data on advertised products, use Readers' Service Cards, last page.



THE ELLIOTT ELECTRICAL CONTROL



Get tight, uniform tube joints everytime and get them fast. The Elliott Electric Control, a torque-limiting device designed for use with any standard tapping motor, automatically balances outside voltage variables (without the need of a separate voltage regulator), controls the torque, and tells you when the tube has been rolled tight.

Speed the operation too with balancer and the Elliott Stabilizer which takes the wobble out of tube rolling. It centers and holds the expander case and cage, allowing operator to keep both hands on the motor. Full details in Bulletin Y-40. Address Elliott Company, Lagonda Division, Springfield, Ohio.

ELLIOTT Company

Y5-6

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

Who's Meeting . . .

design changes could make automating equipment obsolete.

To further liven up the drama, a salesman (M. P. Ferguson, president of Bendix Aviation) was introduced into the plot.

AIChE and ACS Set Joint Meeting

The third annual technical meeting of the Sabine Area section of the American Institute of Chemical Engineers and Texas-Louisiana Gulf section of the American Chemical Society will be held March 9 at Lamar State College in Beaumont, Texas.

Two morning technical sessions have been planned. They will run concurrently. The afternoon program will be a symposium on energy sources.

Registration will be held in the Lamar Tech Engineering Building from 8 a.m. to 2 p.m. Technical sessions will get underway at 9 a.m. A combined luncheon will be served in the Lamar Tech cafeteria for the entire attendance.

Technical Session A will be held in Room 108, Science Building. Papers will be presented on "Analysis of Light Hydrocarbon Mixtures by Gas Chromatography," "Determination of Fluid Catalyst Attrition by Radioactive Tracers," "Use of Mathematical Models in Design and Analysis of Experiments" and "Behavior of Compounds Containing a Neopentyl Carbon Atom."

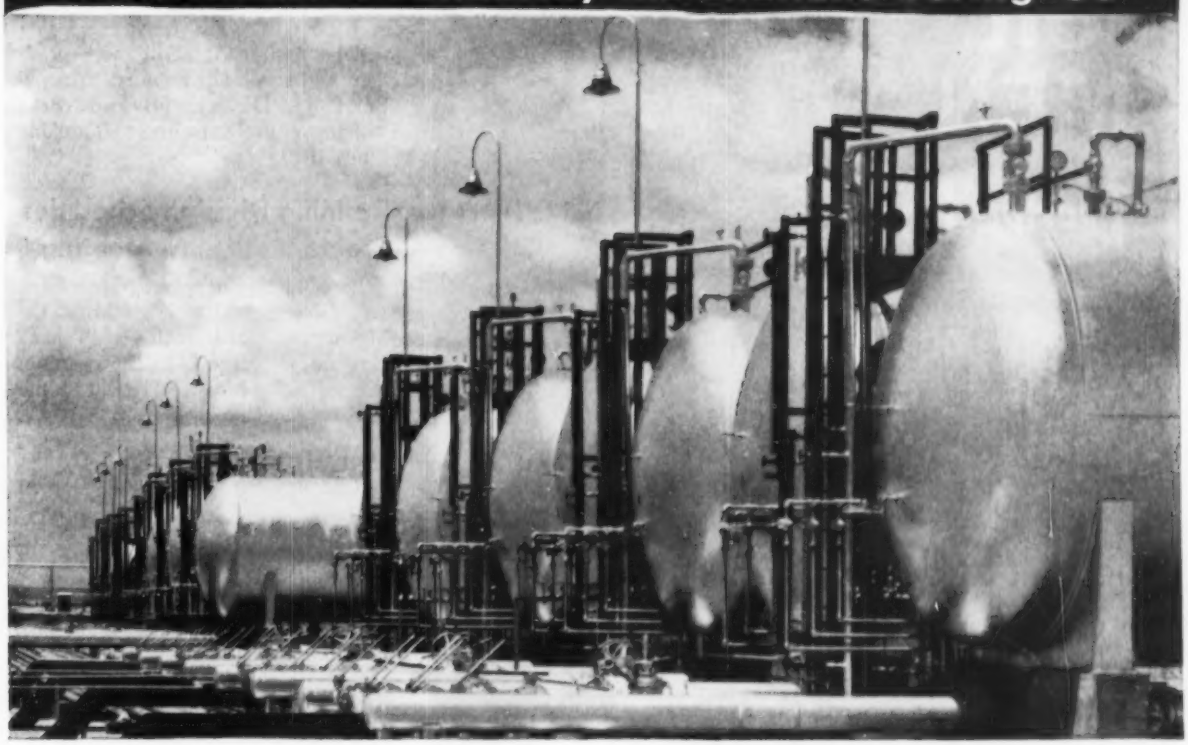
Technical Session B, in the Assembly Hall, will include papers on "The Rotating Disc Contractor," "Creative Thinking in Engineering," "Manufacture of Anhydrous Caustic by Continuous Evaporation," and "Corrosion and Metalurgical Factors in the Failure of Process Equipment."

Both sessions will combine at 11 o'clock in the Assembly Hall for a paper on "Modern Fuels and Engines."

The afternoon program will be an energy sources symposium. Papers to be presented are "Inventory of Known Sources of Energy," "Solar Batteries" and "Gas Turbine Applications in the Petroleum and Chemical Industries."

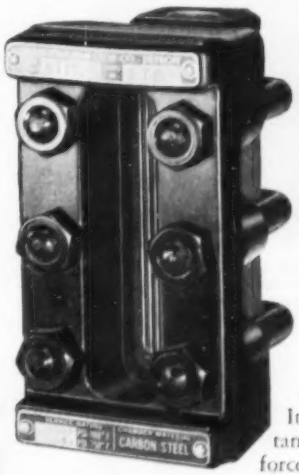
A social hour and banquet will be held at the Hotel Beaumont beginning

Look For More Penberthy Installations During '56



Clear, Accurate...Easily Installed and Maintained for tanks, containers and flow lines...

Liquid Level GAGES and Gage Valves by PENBERTHY



PENBERTHY GAGES
...with exclusive Raised Face

REFLEX liquid level gages.
TRANSPARENT water and liquid level gages.
TRANSPARENT High Pressure liquid level gages.

Frost-free Gages, Heating Tube and Heating Chamber Gages, Welding Pad Gages, Large Chamber Gages, Inclined Gages and Explosion-proof Illuminators.

PENBERTHY GAGE VALVES
...with exclusive Floating Shank

Tubular and Threaded gage valves • Jacketed Gage Valves • Instrument Valves • Wire glass protectors, plate glass protectors, sheet metal guard protectors.

• The Penberthy line is designed specifically for petroleum industry service. They are rugged and reliable . . . engineered with exclusive features to save you time and money.

Savings of 50% and more on installation costs alone are credited to the "floating shank" of Penberthy Gage Valves. It compensates for variations in center-to-center distances of tank tappings or gage assemblies . . . eliminates strains of forced installations.

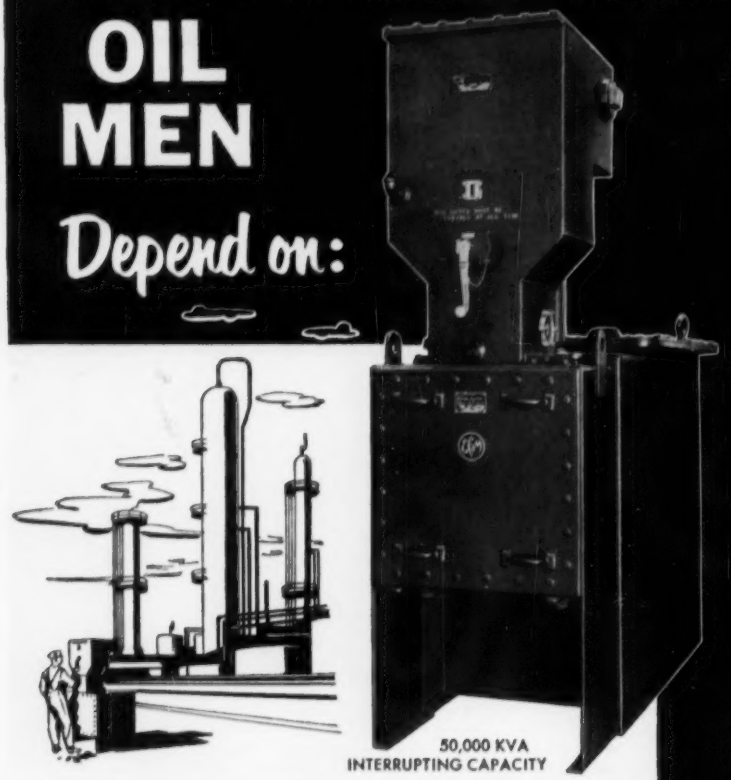
Cleaning or replacement of gage glass is facilitated by the "Raised Face", standard only on Penberthy Gages. Perfect alignment of frame with glass and gasket is assured also.

Feature for feature, Penberthy offers you the best value for your dollar. Compare the line shown in Catalog 35 with any other. We'll be glad to send you this catalog on request. Also sold through supply stores in most fields.

PENBERTHY INJECTOR COMPANY
Division of the Buffalo-Eclipse Corporation
1242 HOLDEN AVENUE **DETROIT 2, MICHIGAN**

For more data on advertised products, use Readers' Service Cards, last page.

OIL MEN Depend on:

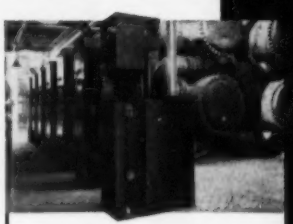


EC&M 2200-5000 VOLT Motor Starters

These EC&M Div. 1 combination Starters for Class I, Group D locations give refinery engineers and construction and design companies top value. They require less floor space . . . line, motor and control leads are brought to conduit connection box for quick installation . . . and high interrupting capacity is inherent . . . 50,000 KVA, and no fuses required.

Oil disconnect switch (on top) may be locked open or closed . . . view windows on both sides show switch contacts. Rear oil-tank has potential transformer for 220-volt push button circuit. Type ZHS (50,000 KVA) Magnetic Contactor may be raised above oil for inspection without disconnecting any bolts or leads.

Before buying, investigate EC&M Combination Starters . . . they provide economy in installation, operation and maintenance . . . and they're complete in every respect.



ADVANTAGES of this Battery of EC&M Starters in a refinery.

1. Combination Starter with self-contained Oil Disconnect Switch
2. All internal wiring complete . . . leads brought to conduit box for easy connection to power and motor leads
3. Heavy duty contactor has alloy contacts
4. Slender design reduces floor space
5. Thermal-Magnetic Overload Relays give accurate motor protection . . . trip instantly on faults
6. Simple 3-wire time-delay UVP push button circuit

Write for descriptive Booklet 1062-VIII

THE ELECTRIC CONTROLLER & MFG. CO.

4498 LEE ROAD • CLEVELAND 28, OHIO

Who's Meeting . . .

at 6:30 p.m. The feature speaker will be Arthur A. Smith, vice president and economist for First National Bank in Dallas. His address: "Changes in Economic Thinking Since 1929."

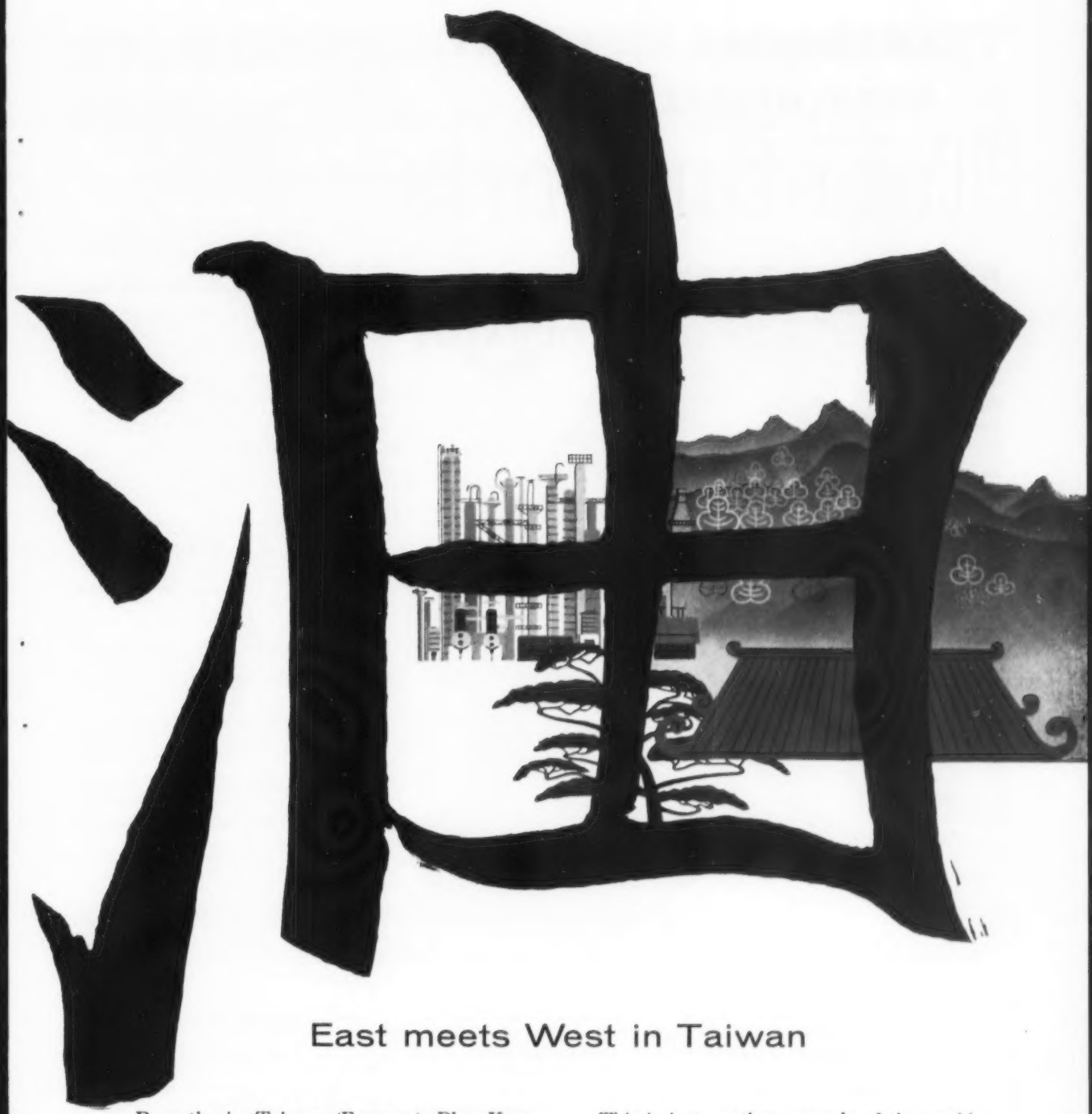
Refining Division Schedules Program for May Meeting

For a preliminary program of the API Division of Refining's Mid-Year Meeting in Montreal, see "What's Happening," page 217. The meeting, scheduled for May 14-17, will be the first held outside the U. S.

MEETINGS CALENDAR

FEB. 12–18	Statistics Short Course for Industry and Physical Sciences, jointly sponsored by the University of North Carolina, North Carolina State College and The Women's College, at North Carolina State College, Raleigh, N. C.
14–17	Third Annual High-Speed Computer Conference Sponsored by the Baton Rouge chapter of National Office Management Association and the Baton Rouge section of the American Institute of Electrical Engineers. At Louisiana State University, Baton Rouge, La.
16	American Chemical Society, Delaware Valley Regional Meeting, Broadwood Hotel, Philadelphia.
24	Natural Gasoline Association of America (Regional Meeting), Lincoln Hotel, Odessa, Texas.
24–25	National Society of Professional Engineers (Spring Meeting), Statler Hotel, Washington, D.C
26–29	American Institute of Chemical Engineers, Statler Hotel, Los Angeles.
27–Mar. 2	American Society for Testing Materials (Committee Week), Statler Hotel, Buffalo, New York.
MAR. 5	Annual Machine Design Conference, Sponsored by Cleveland Engineering Society, Cleveland.
5–7	Chemical Institute of Canada (Divisional Conference), Guildwood Inn, Sarnia, Ont.
12–16	National Association of Corrosion Engineers (Annual Convention) Statler Hotel, New York.
19–21	Mid-West Gas Association, Hotel Fontenelle, Omaha, Neb.
19–21	Western Petroleum Refiners Association (Annual Meeting), Plaza Hotel, San Antonio, Texas.
21–23	Annual American Power Conference, Sponsored by Illinois Institute of Technology, Hotel Sherman, Chicago.
APRIL 2–4	American Institute of Electrical Engineers (Southwest District 7), Dallas, Texas.
3–5	Annual Corrosion Control Short Course, University of Oklahoma, Norman, Okla.
4–6	American Gas Association, General Management Conference, Conrad Hilton Hotel, Chicago.
8–11	American Chemical Society (National Meeting), Dallas, Texas
11–13	Natural Gasoline Association of America (Annual Convention), Texas Hotel, Fort Worth, Texas.
14–18	Petroleum Equipment Suppliers Association, Annual Meeting, Boca Raton Hotel, Boca Raton, Fla.
17–19	Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, Oklahoma.
18–20	National Petroleum Association (Semi-Annual Meeting), Cleveland Hotel, Cleveland, Ohio.

Continued on Page 184



East meets West in Taiwan

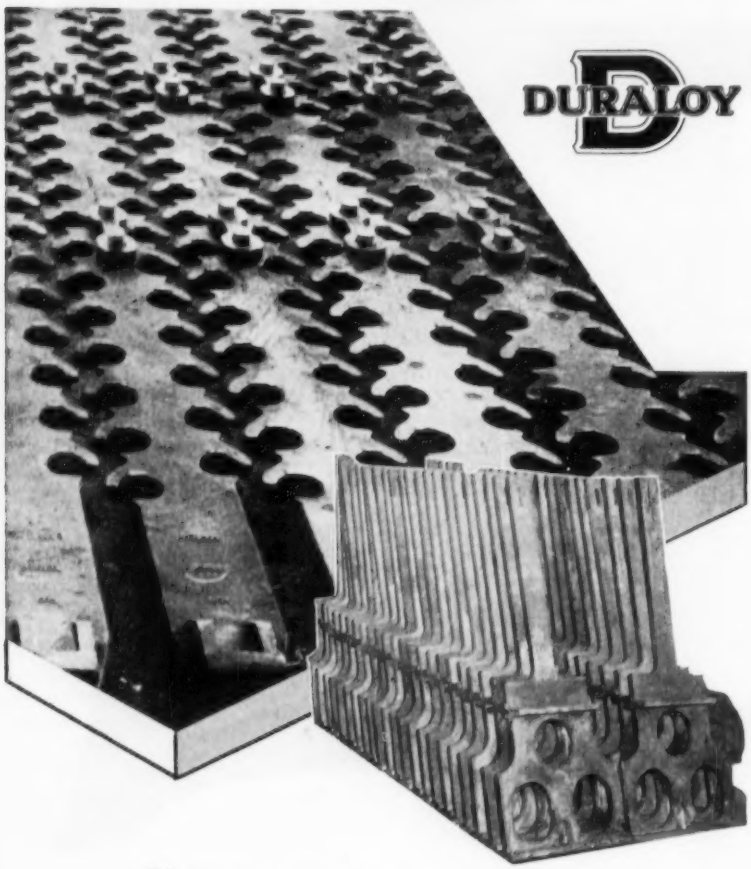
Recently in Taiwan (Formosa), Blaw-Knox placed on stream the first Catformer in the Orient for its owners, the Chinese Petroleum Corporation. This plant was designed and procured by Blaw-Knox's Chemical Plants Division, who also supervised erection which was completed in the record time of four months. Chinese labor under the direction of Chinese engineers and skilled technicians performed the actual construction work.

This is just another example of the world-wide achievements of Blaw-Knox engineers, who are ready to help you in the engineering, procurement and construction of a single unit or a complete refinery.

BLAW-KNOX COMPANY
Chemical Plants Division
Pittsburgh 30, Pa. • Chicago 1, Ill.
Birmingham, New York, Philadelphia, San Francisco, Washington, D.C.

油, yu²—oil

CORROSION RESISTANT
HEAT RESISTANT
Tube Supports



You can't buy Better Tube Supports . . . DURALOY Tube Supports are alloyed to meet individual corrosion and heat requirements. They are alloyed by experienced metallurgists and melted and cast by experienced high-alloy foundrymen, both groups with experience going back some thirty years. Castings are carefully tested in our own laboratories which are completely equipped for metallurgical, chemical and physical testing.

Many refineries have been DURALOY customers for years. Many refineries insist upon DURALOY castings. Whether it's straight production or engineering plus production, we are equipped to do the job. For more information, send for Bulletin No. 3150-G.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • Eastern Office: 12 East 41st Street, New York 17, N.Y.

Detroit Office: 2306 Woodward Avenue • Pleasant Ridge, Mich.

Atlanta: J. M. TULL Metal & Supply Co. — Chicago: T. O. NELSON 332 S. Michigan Avenue

METAL GOODS CORP. Dallas • Denver • Houston • Kansas City • New Orleans • St. Louis • Tulsa

MEETINGS, continued

APRIL	
18–20	Conference on Marine Corrosion and Fouling Problems, University of California, La Jolla campus.
23–25	American Oil Chemists Society, Annual Spring Meeting, Shamrock-Hilton Hotel, Houston.
23–25	Chemical Progress Week.
25	Association of Consulting Chemists and Chemical Engineers (Symposium), Belmont Plaza, New York.
25–29	World Oil Exposition, Houston.
26–27	American Institute of Electrical Engineers (National Meeting), Bradford Hotel, Boston.
27	Society of Chemical Industry, Chemical Industry Medal Presentation, Waldorf-Astoria Hotel, New York.
30–May 4	American Petroleum Institute (Safety and Fire Protection Mid-Year Meeting), Warwick Hotel, Philadelphia.
MAY	
1	Independent Petroleum Association of America, (Semi-annual Meeting), Statler Hotel, Los Angeles.
4	American Petroleum Institute (Safety and Fire Prevention Annual Mid-Year Meeting), Warwick Hotel, Philadelphia.
6– 9	Liquefied Petroleum Gas Association (Convention and Trade Show), Conrad Hilton Hotel, Chicago.
6– 9	American Institute of Chemical Engineers, Roosevelt Hotel, New Orleans.
14–17	American Petroleum Institute, Division of Refining (Mid-Year Meeting), Sheraton-Mount Royal Hotel, Montreal, Canada.
15–17	Industrial Waste Conference, Purdue University, Lafayette, Ind.
16–18	American Gas Association, (Chemical Engineering and Manufactured Gas Production Conference), Benjamin Franklin Hotel, Philadelphia.
24–25	Natural Gas and Petroleum Association of Canada, Sheraton-Brock Hotel, Niagara Falls, Ont.
28–30	Chemical Institute of Canada (Annual Conference and Exhibition), Mount Royal Hotel, Montreal, Quebec.
30–June 1,	Short Course on Gas Technology, Sponsored by Texas A&M College, Kingsville, Texas.
JUNE	
11–15	Technical Conference on Plastics, Sponsored by The Society of the Plastics Industry, Inc., Coliseum, New York.
17–22	World Power Conference, Vienna, Austria.
17–22	American Society for Testing Materials (Annual Meeting and Apparatus Exhibit), Chalfonte-Haddon Hall, Atlantic City, N.J.
21–22	Western Petroleum Refiners Association, Regional Technical-Industrial Relations Meeting, Broadview Hotel, Wichita, Kans.

Copies of Index Still Available

Copies of the 1955 PETROLEUM REFINER Index, which in the past always has appeared in the December issue, are still available to subscribers—now upon request. Readers who want this valuable guide to the past year's advancements in refining, petrochemicals and natural gasoline should use the Reader's Service green card in the back of this issue. Write on the card, "1955 PETROLEUM REFINER Index," fill in name, address and mail. There is no charge or obligation.

SPECIAL INDUSTRIAL CONCRETES made with LUMNITE*

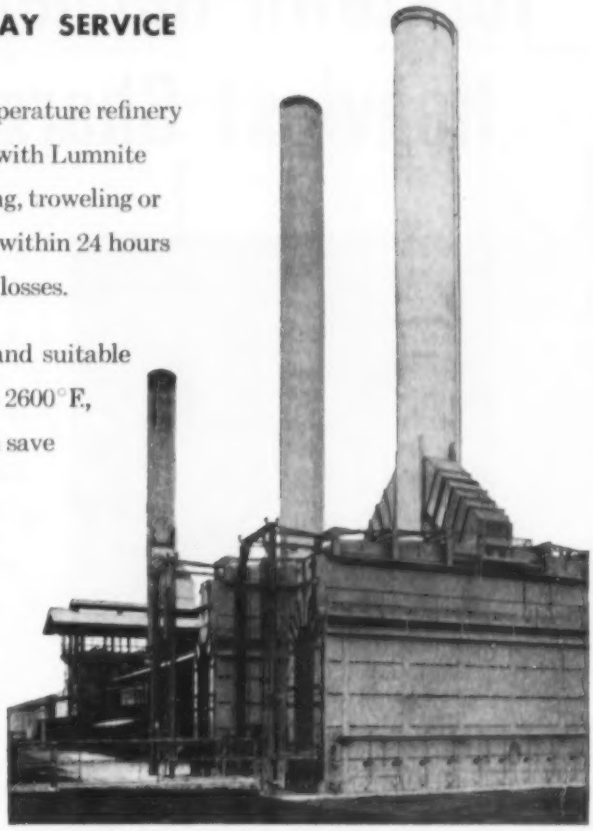
help solve heat, corrosion and insulation problems—FAST!

PLACE THEM 3 WAYS FOR 3-WAY SERVICE

Speed up construction and repair work on high-temperature refinery installations with special industrial concretes made with Lumnite calcium-aluminate cement. Easily placed—by pouring, troweling or cement gun—these concretes reach service strength within 24 hours ... help reduce downtime and minimize production losses.

Industrial concretes made with Lumnite cement and suitable aggregates give you 3-way service—resist heat up to 2600°F, resist corrosion, and *insulate* as well. Often you can save valuable time and cost by specifying one concrete that will do several jobs.

For added convenience, you can use prepared castables (packaged mixes of Lumnite cement and aggregates selected for specific temperature and insulation requirements—add only water). They're made and distributed by leading manufacturers of refractories.



LONGER-LASTING LININGS—These Universal Oil Products Company heaters and stacks have special Refractory Concrete linings made with Lumnite Cement that resist heat and corrosive effects of condensate.

USE SPECIAL INDUSTRIAL CONCRETES FOR:

1. **REFRACTORY INSULATING CONCRETE**—in strippers, rerun chambers, reactors, regenerators, fractional distillation and thermal alkylation units.
2. **ABRASION-RESISTANT REFRACTORY CONCRETE**—Catalyst transfer and discharge lines, reforming chambers, gas coolers, reactor cyclones and transfer lines, regenerator cyclones and return lines.
3. **REFRACTORY CONCRETE**—in bubble and flash towers, continuous-pressure stills.
4. **CORROSION-RESISTANT AND REFRACTORY INSULATING CONCRETE**—linings in regenerator exhaust lines, stacks, ducts.
5. **CORROSION-RESISTANT CONCRETE**—in linings for sweetening and storage tanks, waste-disposal systems, and trenches.

FOR MORE INFORMATION

write Lumnite Division, Universal Atlas Cement Company (United State Steel Corporation Subsidiary), 100 Park Avenue, New York 17, New York.

OFFICES: *Albany, Birmingham, Boston, Chicago, Dayton, Kansas City, Minneapolis, New York, Philadelphia, Pittsburgh, St. Louis, Waco.*

**"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

PR-L-104

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

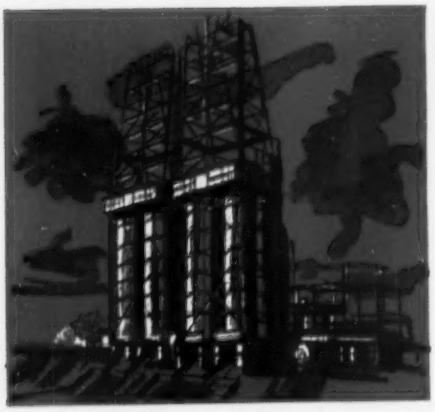
REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

UNITED STATES STEEL HOUR—Televised alternate weeks—See your newspaper for time and station.

For more data on advertised products, use Readers' Service Cards, last page.

Lummus Coker for Yorktown Refinery Will Handle Heaviest Charge on Record



The Delayed Coking Unit for the new Yorktown, Virginia refinery of The American Oil Company will handle the heaviest feed ever charged to a Delayed Coker. The Lummus Company has been selected to design and construct the unit. Special techniques have been developed in Lummus laboratories and pilot plants to handle such heavy stocks.

Charge to the Unit will be vacuum reduced crude which will have 25.0% Conradson Carbon and an API gravity of 6.1°. SFS at 210°F is 6000. The products will be gas oil, gasoline, gas and C4's, plus 600 tons per day of coke. The Unit is also designed to handle lighter stocks at a maximum capacity of 9,660 B/D.

The Coking Unit will have four coke drums. The Lummus Heater, which is the heart of this process, incorporates the critical design factors to meet the wide range of charge stocks and throughputs.

The new coker will come on-stream late in 1956. As an integrated part of the Yorktown Refinery, it will help supply motorists' demand for more of the American Oil Company's premium unleaded motor fuel, "Amoco-Gas," marketed in 18 states from Maine to Florida.

Lummus has designed, engineered and constructed a large percentage of this country's modern coking capacity. Lummus can build a coker . . . or a complete refinery . . . for you. Let Lummus engineers show you how 50 years experience with over 700 major installations will produce maximum return on your capital investment.

The Lummus Company, 385 Madison Avenue, New York 17, New York. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Ind.

AMOCO

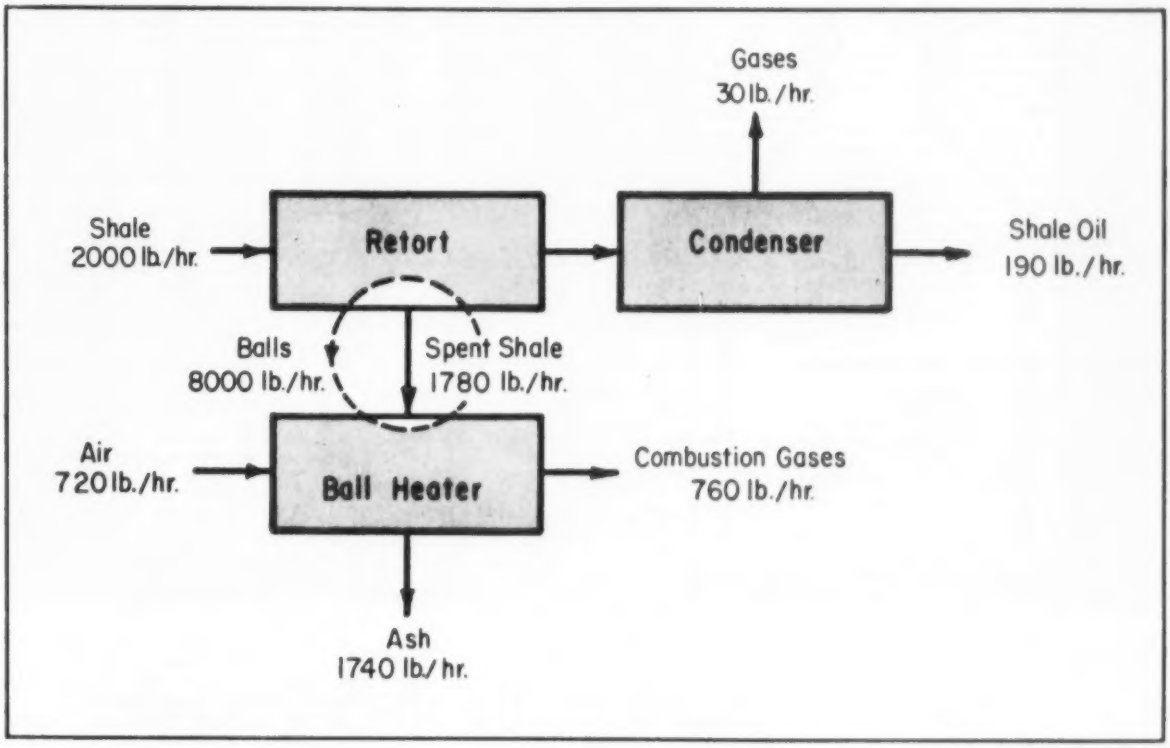
LUMMUS

DESIGNING ENGINEERS AND CONSTRUCTORS
FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

For more data on advertised products, use Readers' Service Cards, last page.

Who's Building . . .

Next Construction Boxscore to appear in April issue.



Research institute to use Aspeco process.

Denver Shale-Oil Plant To Use Swedish Process

DENVER RESEARCH Institute will build and operate a shale-oil pilot plant in the Denver area, using a Swedish process.

The institute, affiliated with the University of Denver, signed a $250,000 contract to use the Swedish Aspeco process. The contract was made with Oil Shale Corporation, a California concern with North American rights to the process.

The process is patented by Aspeco & Company, a firm of consulting engineers in Stockholm.

Purpose of the Denver project is to determine the possibilities for using the Aspeco process with Colorado shales. If successful, the plant is expected to reduce the cost of producing shale oil from the present 16 cents a gallon to a competitive 13 cents.

Plans call for a 24-ton-a-day pilot plant to be built in the shops area of the Denver & Rio Grande Western Railroad yards in Denver. If the process comes up to expectation, licenses will be available for commercial installation.

This will be the third shale-oil pilot plant to take up the processing of Colorado shales. Bureau of Mines has a retort—no longer in operation—at Rifle. It was closed down after Union Oil Company of California announced plans to build private industry's first U. S. plant. The company now has a $5-million project underway at Rifle. Other companies have operated laboratory-scale operations.

The Aspeco process consists of two horizontal, rotating kilns, one a retort for heating raw shale to pyrolysis temperatures and the other a heat exchanger and combustion furnace for

Who's Building...

burning off carbon from spent shale.

In both kilns, properly sized, crushed shale flows countercurrent to closely-sized steel balls. Heat transfer is made through solid-to-solid contact.

In the pyrolysis drum, previously-heated balls at 1000 F. and cold crushed shale enter opposite ends of the kiln and flow in countercurrent contact. The spent shale, containing residual carbon, leaves the kiln at 900 F., and the cooled balls exit from the opposite end at 250 F.

These two streams are re-contacted in countercurrent fashion in the combustion kiln. Air is introduced and the spent carbon burned off the shale. The balls are thus reheated and discharged at 1000 F. for recycling to the retorting kiln.

If required, a side stream of oil-denuded off gases from the upper kiln may be used to supplement the ball-heating requirements in the lower kiln. A ball-heating tower, gas-fed, is provided for start-up.

Standard - Vacuum Oil Company will install a fluid catalytic-cracking plant, a catalytic-polymerization unit and other improvements at its Sungei Gerong refinery near Palembang, Indonesia. The modernization projects, estimated to cost $20 million, are part of Stanvac's four-year $80-million capital investment program in Indonesia.

Foster Wheeler Corporation will build the two process units. The 11,000-barrel-a-day cracking plant will supplement pre-war thermal cracking facilities now in operation. It also will provide feed stock for the alkylation plant.

Gas from the cracking unit will be compressed and segregated as feed stock for the new 1200-barrel-a-day polymerization plant and the alkylation plant.

Shell Chemical Corporation has plans for installing ammonia-container loading facilities at its Ventura, Calif., ammonia plant. Design work of equipment will be done by Ehrhart and Associates.

General Tire & Rubber Company plans to expand its Ashtabula, Ohio, chemical plant by 50 percent. The project will be undertaken because of the heavy demand for polyvinyl-chloride resin. The company's $6-million plant was put in operation about a year ago.

Suntide Refining Company has a major expansion underway at its Corpus Christi, Texas, refinery. The plant went on stream early in 1954 with a daily capacity of 26,300. When the present project is complete, Suntide capacity will be 65,000 barrels a day.

Standard Oil Company of California is studying the possibilities for building a refinery in Panama. The refinery would be at Colon and cost the company some $40 million to build.

Azienda Generale Italiana Petroli, affiliated with The British Petroleum Company, Ltd., has gone on stream with a new catalytic-reforming unit at the Porto Marghera refinery in Venice. The unit, Italy's first Platformer, has a daily capacity of 1750 barrels. It will be used to produce a high-grade gasoline component.

Mississippi Project Leads in Write-Offs

Pontiac Eastern Corporation has been awarded a fast tax write-off certificate on more than $18 million, for construction of a 12,000-barrel-a-day refinery at Hattiesburg, Miss.

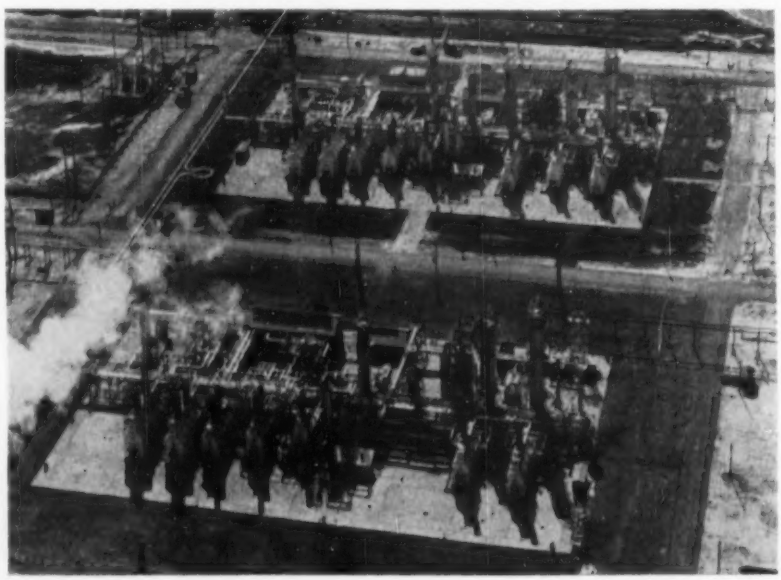
Office of Defense Mobilization also issued The Sunshine States Refineries, Inc., a certificate on $9,750,000, for construction of a 10,000-barrel-a-day refinery in Florida's Hillsborough County.

Sunshine States was cleared for accelerated amortization at the fast rate of 65 percent on $7,900,000, 45 percent on $1,770,000, and 15 percent on $75,000.

Pontiac Eastern was allowed 65 percent on $9,457,000 for refining facilities; 100 percent on $2,939,800 for alkylation equipment; 45 percent on $4,520,300 for auxiliary units; 25 percent on $861,500 for pipe lines, and 15 percent on $321,000 for buildings.

Other certificates were issued as follows:

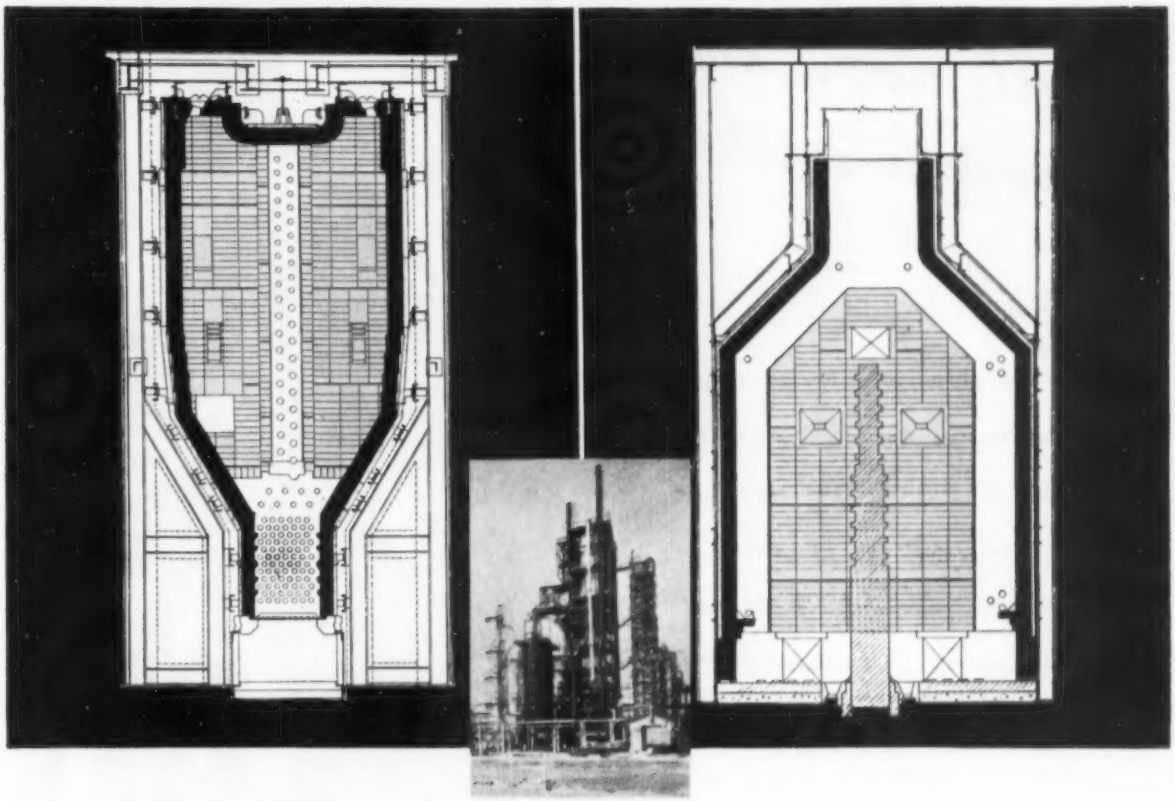
- Phillips Petroleum Company, approved for a 65 percent write-off on $22,045, for expansion of its gasoline plant at Phillips, Texas.
- American Oil Company, allowed to write off 65 percent on $346,000 and 40 percent on $60,000. This will be for modification and expansion of its catalytic-cracking and reforming facilities at Texas City, Texas.
- D-X Sunray Oil Company, given an allowance for expansion of its catalytic-cracking unit in Duncan, Okla. This company was issued a certificate for 65 percent on $199,000.
- Phillips Chemical Company, issued a certificate for $12,500,000 worth of installations at its Sweeny, Texas, plant. Write-offs were approved at 65 percent on $11,110,315 for refinery construction; 45 percent on $1,385,185 in auxiliary facilities and 15 percent on $41,500 for buildings.
- Continental Oil Company, cleared for amortization on a 6270-barrel-a-day catalytic reformer and hydrodesulfurization unit at its Billings, Mont., refinery. Write-offs will be for 65 percent on $884,341 and 45 percent on $111,311.
- The Pure Oil Company, given a certificate for construction of a 15,000-barrel-a-day catalytic-reforming unit at its Smiths Bluff, Texas, refinery. The government will allow $4,535,000 to be written off at the fast rate of 65 percent and $897,000 to be covered at 45 percent.
- Ashland Oil & Refining Company, approved for a 50-percent write-off on $1,100,000 and a 65 percent write-off on $4,150,000. This covers construction of a 50,000-barrel-a-day crude-fractionation unit and a 20,000-barrel-a-day catalytic-cracking unit at Ashland's Catlettsburg, Ky., refinery.
- Cooperative Refining Association, cleared for $3,912,000 to be written off at 65 percent; $85,000, at 40 percent, and $63,000, at 15 percent. This allowance is for building a 4200-barrel-a-day catalytic reformer, a 3000-barrel-a-day hydrogenation unit and an 8000-barrel-a-day coking plant at Coffeyville, Kansas.
- D-X Sunray Oil Company, given a 65-percent write-off on $828,000, for expansion of catalytic-cracking and gas-recovery equipment at its Tulsa refinery.
- Texas City Refining Company, issued a certificate for construction at Texas City, Texas. The company will be allowed to write off $1,084,936 at 100 percent and $100,000 at 50 percent. This will cover expansion of the refinery's alkylation facilities.
- Bankline Oil Company, for reactivation of an 800-barrel-a-day alkylation unit at Bakersfield, Calif., allowed 100 percent on $500,000.
- The Texas Company, approved for a certificate on $2,743,000 at the 65-percent rate. This is to cover new equipment at Texaco's Casper, Wyo., refinery.
- Olin Mathieson Chemical Corporation, allowed a 50-percent write-off on



Gas-Recovery Plant at Hamburg—

General view of the recently-completed gas-recovery plant at The British Petroleum Company's refinery in Hamburg. The new German plant has a daily capacity of about 1000 barrels a day of butane and propane. The refinery has a daily capacity of 25,000 barrels.

Profitable trends in the use of refractories



Laclede-Christy offers simplified way to get exact-purpose refinery refractories

It's highly profitable, of course, to use refractories exactly suited to each application. There's a simple way to do this. That is to rely upon one source which offers you each refractory type and grade that you may need—plus the quality and service you expect.

Laclede-Christy produces a variety of castable refractories for refinery use—to meet a wide temperature range. Two are particularly successful in refinery vessel applications—Porelite V.L. for its high insulating properties and lightness, and Firmcast for its extra strength and abrasion resistance.

Where you may need suspended arch and sectionally supported wall construction, Laclede-Christy again provides exact-purpose refractories. In fact, Laclede-Christy offers the most extensive experience obtainable in the engineering of suspended arch and wall construction.

If you need help to determine your exact-purpose refractory, Laclede offers that too. So, for a profitable trend in your use of refractories, get together with Laclede-Christy soon. A representative is nearby.

LACLEDE-CHRISTY COMPANY DIVISION

LACLEDE-CHRISTY COMPANY · FOUNDED 1844 · Quality First · HKP

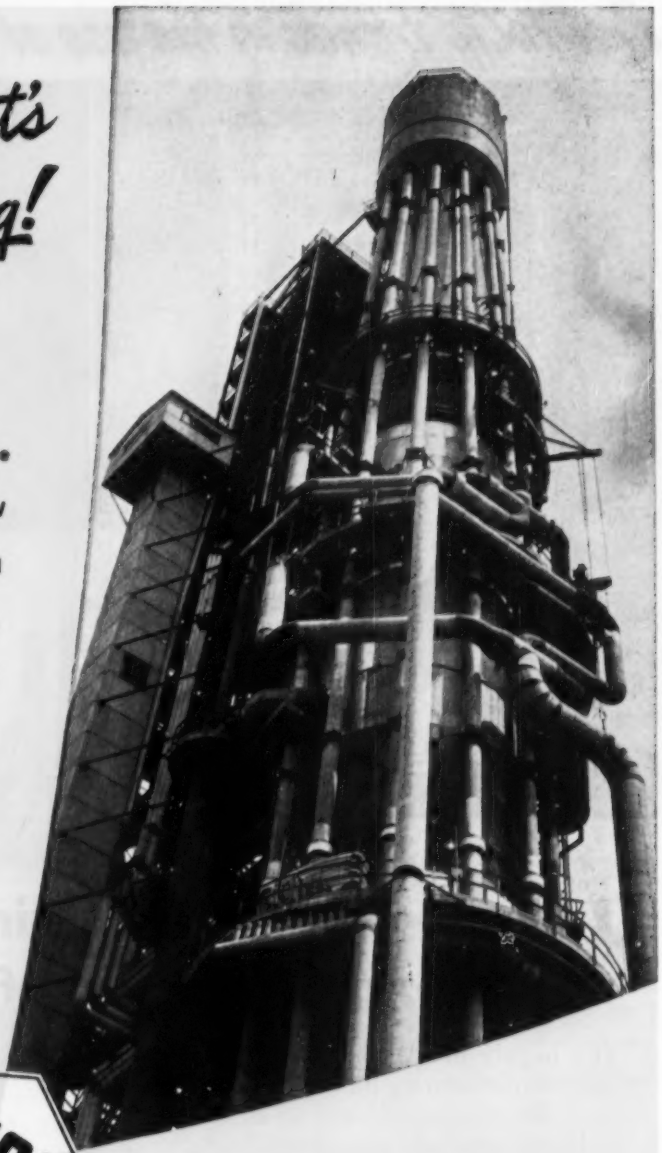
H. K. PORTER COMPANY, INC.
2000 Hampton Ave. · St. Louis 10, Missouri

For more data on advertised products, use Readers' Service Cards, last page

Well, now... that's very interesting!

but what is it?

By now, many refiners would recognize this giant as the new HOUDRIFLOW unit of the SUN OIL COMPANY located in Marcus Hook, Pa. Equivalent in height to 35 stories . . . 30,000 bbl./day capacity . . . this cat-cracker (only the upper half of which is shown here) was erected at a cost of approximately eight million dollars. It is the largest unit of its type in the world.



SUNOCO

And in the Quench Section and Vacuum Section this mighty "cat" chose Western Heat Exchangers constructed of alloy steel. Western backed its bid for this business with service that helped put the big HOUDRIFLOW on stream as scheduled.

WESTERN
HEAT EXCHANGERS
WESTERN SUPPLY COMPANY
P. O. BOX 1888 • TULSA, OKLAHOMA

HUDSON-RUSH COMPANY—753 Gladstone Blvd., Shreveport, La.
130 Casa Linda Plaza, Dallas 18, Texas
PROCESS INSTRUMENTS & EQUIP. CO. - North Bldg., Charleston, W. Va.
H. W. SEVERANCE—Marion E. Taylor Bldg., Louisville, Ky.

Who's Building. . .

$555,000 and 100-percent on $1,085,000. This is for refining and aklylation facilities at Doe Run, Ky.

Empresa Petrolera Fiscales, the Peruvian government's oil agency, is nearing completion on the first refinery in the Amazon basin. At Iquitos, the plant will have a daily capacity of 1500 barrels.

Originally located on Peru's northern coast, the plant, named Refineria Villar, was dismantled early in 1954, and work was started on relocating the refinery near the headwaters of the Amazon River.

Heavy equipment was taken by ship through the Pacific, through the Panama Canal, across the Caribbean and past the Atlantic to the mouth of the Amazon. From there it was moved upstream 6700 miles.

Lighter equipment was taken over the Andes by truck and then carried down stream in river craft to Iquitos.

Included in the plant's equipment is a virtually automatic-controlled topping plant with a condensation bubble tower. The refinery also has an ethyl-mixing plant for upgrading straight-run gasoline.

In addition to gasoline, the refinery will turn out kerosine, diesel oil and bunker fuel. The government agency also is considering the installation of a lube-oil plant.

Cie. de Combustiveis de Lobito Purfina has been cleared by the Portuguese government for construction of a refinery at Angola, West Africa. Engineering studies have been started on a plant of at least 10,000-barrel-a-day capacity. The company, a subsidiary of Cie. Financiere Belge de Petroles, S. A., will award construction contracts in the next few months. Petrofina expects the project to take about two years.

Arkansas Fuel Oil Corporation is installing reforming facilities at its Carthage, Texas, natural-gasoline plant. The equipment, a Platforming unit set for completion in May 1956, is expected to upgrade the plant's gasoline to a 98-octane rating. A new feed-preparation unit for the reformer also is being built. Design work on the new installation was handled by Universal Oil Products Company.

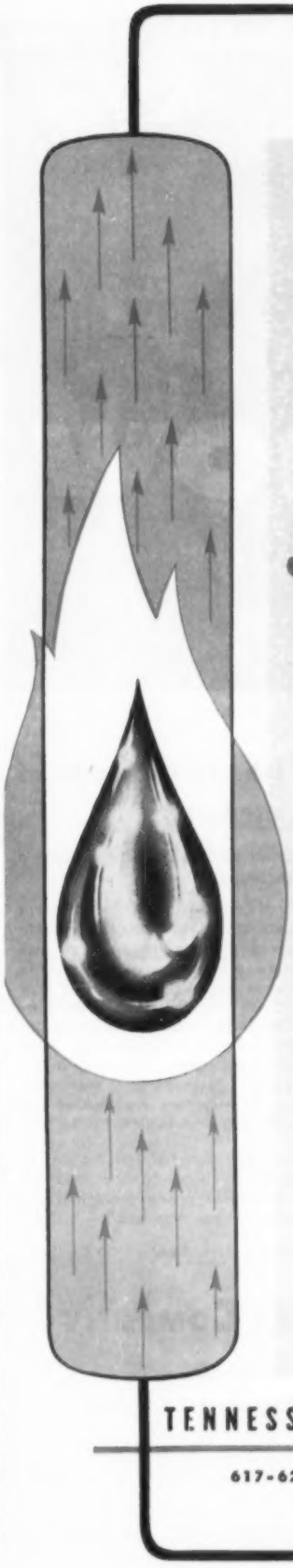
Phillips Petroleum Company has started construction on a $7-million natural-gasoline plant near Andrews, Texas. Construction is being handled by Gasoline Plant Construction Company. The plant is due for completion in the summer of 1956.

Commonwealth Oil & Refining Company has gone on stream with Puerto Rico's second new refinery, a 25,000-barrel-a-day installation at Ponce on the south coast. Engineering and construction of the $25-million refinery was handled by The Lummus Company.

Earlier, Caribbean Refining Company put on stream a new 10,000-barrel-a-day refinery at San Juan. Together these refineries are expected to satisfy Puerto Rican demands for petroleum products and provide a surplus for export.

Part of the Commonwealth plant's output will be sold to Sun Oil Company for U. S. import. It will be further processed at Sun's Marcus Hook, Pa., refinery.

Process equipment for the refinery at Ponce includes a catalytic-cracking plant



TC

TENNESSEE'S LIQUID

SULFUR DIOXIDE

HIGHEST QUALITY

SO_2

A SOLVENT of Economy and Effectiveness

Tennessee's Liquid Sulfur Dioxide, a product of highest purity, is particularly suitable as a solvent for recovery of aromatics—It is completely miscible with aromatic hydrocarbons over a wide temperature range, while the solubility of napthene and paraffin hydrocarbons is limited and increases with decreasing temperature. Recovery of a higher percentage of aromatics is obtained for hydrocarbons over a wide boiling range.

Perhaps Tennessee's highest purity Liquid Sulfur Dioxide can effect a more efficient and economical operation in your processing. We would like to discuss these possibilities with you.

Available In:

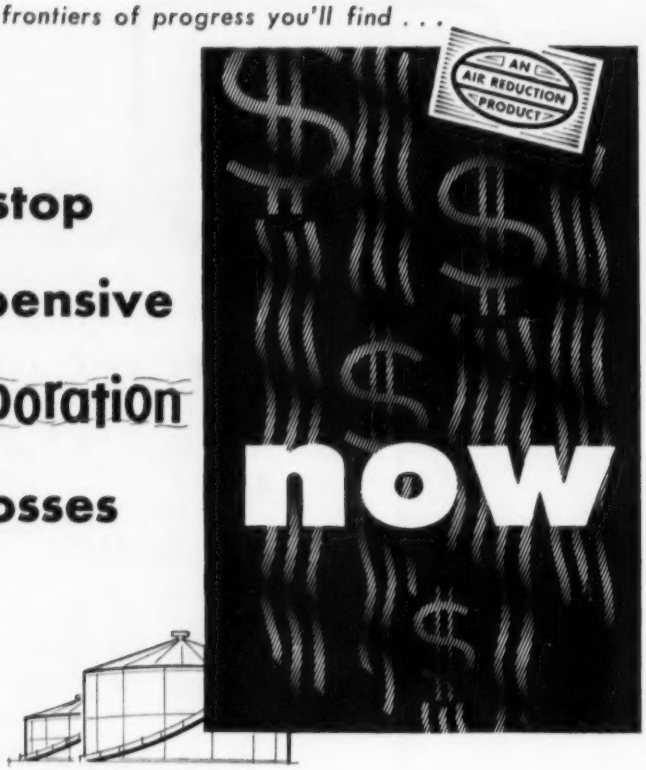
- CYLINDERS
- TON DRUMS
- TANK TRUCKS and
- TANK CARS

TENNESSEE TC CORPORATION

617-629 Grant Building, Atlanta, Georgia

For more data on advertised products, use Readers' Service Cards, last page.

at the frontiers of progress you'll find . . .



COLFOAM MICROBALLOON* spheres cut waste of stored crude oil and products

Until the development of Colfoam Microballoon Spheres, cone-roof tanks were extremely wasteful of stored crude oil and products. In fact, these tanks were more like uncorked bottles — so far as controlling evaporation was concerned.

Then Colfoam Microballoons entered the picture. Years of testing and actual experience prove that a blanket of Colfoam Microballoon Spheres reduces costly evaporation losses by as much as 86%. Colfoam Microballoon blankets are easily installed, require no upkeep and soon pay for themselves through money-saving conservation of crude oil and products.

"Bought by the pound and used by the fraction of an inch," urea formaldehyde Colfoam Microballoons are microscopically-small, gas-filled spheres which float on top of crude oil and products and form a foam-like seal.

Buyers of Colfoam Microballoon Spheres enjoy many advantages from Colton Technical Service at no additional cost. Surveys, made prior to purchase, estimate what savings can be expected and how much material is needed. Following supervised installations, actual savings are determined. A Portable Gage Tape Well that aids in accurately measuring stored material and a Foam Sampler that measures foam thickness are supplied as well as complete technical bulletins.

Write today for full information on Colfoam Microballoon Spheres and for proof of substantial savings through drastic reduction of evaporation losses.

*COLFOAM Reg. T. M. Colton Chemical Co. MICROBALLOON Reg. T. M. Standard Oil Co. (Ohio)

COLTON CHEMICAL COMPANY

A DIVISION OF AIR REDUCTION CO., INC.

1545 East 18th Street, Cleveland 14, Ohio

SALES Offices and Warehouse Facilities Throughout U. S.
EXPORT: Airco Company International, New York 17, N. Y.

Products of other divisions of Air Reduction Co., Inc. include; AIRCO — industrial gases, welding and cutting equipment PURECO — carbon dioxide, liquid-solid ("DRY-ICE") OHIO — medical gases and hospital equipment NATIONAL CARBIDE — pipeline acetylene and calcium carbide.

Who's Building . . .

and reforming facilities. The cracker, a Houdriflow unit, was built for a daily capacity of 26,800 barrels; the reformer, also licensed by Houdry Process Corporation, has a 3700-barrel-a-day capacity.

Near the Commonwealth refinery, an anhydrous-ammonia plant is under construction. Gonzales Chemical Company is building the plant for a daily output of 115 tons. The Lummus also is handling engineering and construction for this project, due to cost $12,250,000.

Gulf Natural Gas Corporation is building a natural-gasoline-extraction plant in Louisiana's Caddo Parish. The plant, now about 75-percent complete, will have a daily capacity of 20 Mmcf.

It's compression facilities will be of conventional design with a total of 4400 compression horsepower. Compressor foundations and piping are designed for further expansion.

The liquid recovery equipment will be a refrigeration-type plant using glycol injection. The chiller will operate at 0 F. at 500 psig. Condensed liquid from the low-temperature separator will be charged to a separator, using a cold-feed reflux system.

Initially, the plant will turn out natural gasoline only. The stabilizer has sufficient trays, however, to be converted to a deethanizer when economics warrant LPG production. The refrigeration system will use propane as a refrigerant, with 440 refrigeration compression horsepower.

A/S Norske Esso is negotiating with the Norwegian government for construction of a refinery in Norway. No decision has been reached. The company is affiliated with Standard Oil Company (New Jersey).

El Paso Natural Gas Company will build an alkylation plant and blending plant, for upgrading natural gasoline and other products turned out in connection with its natural-gasoline operation. (**See What's Happening.**)

The alkylation unit will be built somewhere on the company's projected product pipe line from the Permian Basin to El Paso, Texas. Alkylate will be piped to the blending plant at El Paso, where it will be blended into premium gasoline.

W. R. Grace & Company, with Germany's Farbwerke Hoechst, A. G., will build a plant in Brazil, for the production of low-pressure polyethylene. This is a step in the plans of the two companies to develop a full line of essential chemicals in Brazil. They are nearing completion of a plant for making such products as monochlorobenzene, solvents, detergents.

Cosden Petroleum Corporation has placed on stream a 2100-barrel-a-day Unifining unit at its Big Spring, Texas, refinery. The unit, built by Cosden personnel, cost about $137,000. It will process about 30 percent of the charge to the refinery's existing Platformer.

Shell Chemical Company will start construction on a 36,000-ton-a-year urea plant at Ventura, Calif. This is the second refining company to take up urea production. Standard Oil Company (Ohio) was the first to enter this field when it started its new Lima, Ohio, plant. Shell will use

Inco high temperature research note:

Carburization

...and its effects on metals at high temperatures

With sufficient background of information on the strength properties and corrosion characteristics, it should be entirely possible to predict the performance of an alloy under any conditions of high temperature service.

Method of Obtaining Data

Data relating to the mechanical properties may be obtained in the laboratory by any of the conventional testing methods . . . on the other hand, the problem of high temperature corrosion resistance is often so complex that it is frequently more convenient to place test specimens in an actual service environment than to try simulating industrial conditions on a laboratory scale.

This course is being pursued by Inco's high temperature engineers working in the field and in laboratories at Bayonne, N. J. and Huntington, W. Va. Creep and rupture tests at temperatures as high as 2100°F have supplied data on the strength properties of high nickel alloys. Corrosive attack by various hot atmospheres, fused salts and molten metals is being studied principally in the field to provide the type of information that will assist industry to select more suitable, longer lasting materials for various high temperature applications.

Effects of Carburization

Carburization – as may result from contact with carbonaceous atmospheres in petro-chemical or petroleum refining operations or during the heat treatment of steel parts–is one type of high temperature reaction which, under certain conditions, can change the properties of heat resistant alloys and adversely affect their performance.

Carbon diffuses into the metal and subsequently precipitates as a carbide particle rich in chromium. Compared to the alloy matrix, the carbide phase is hard and brittle. If distributed throughout grain boundaries, the particles provide a continuous path for brittle failure. (See micrograph below.) In certain types of service, carburization of a heat-resisting alloy may not be a serious matter. But in the usual case where the metal part or structure may be called upon to exhibit some measure of ductility or be subjected to impact or to drastic temperature changes, carburization often leads to premature failure.

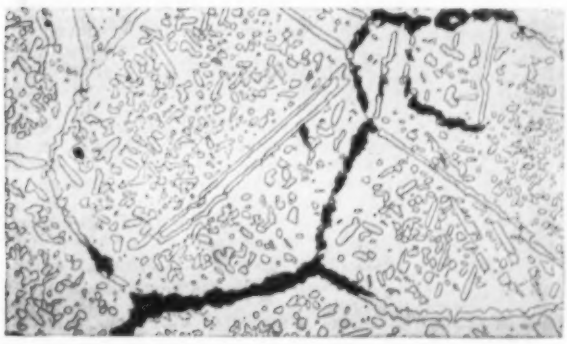
Nickel Plays Basic Role

In general terms, the susceptibility of iron-chromium-nickel alloys to carburization seems to depend upon the relative amounts of the individual components – but not as one might expect. Iron and chromium form stable carbides, while nickel does not. Yet Inco test data show that chromium has a greater effect than either iron or nickel. But it has also been demonstrated that for a given amount of chromium its beneficial effect is much greater at a higher nickel level than at a lower. Conversely, for given nickel content it would be expected that an alloy containing a higher chromium content would be more resistant to carburization.

Assistance Available

Inco high temperature corrosion test data also suggest that silicon improves carburization resistance, as does the presence of carbide stabilizing elements, such as titanium and columbium. Under extremely severe conditions of carburization, the effect of these elements is but temporary, and after sufficiently long exposure, their value is lost.

In a fast growing field such as this, it is impossible to have an immediate answer to every problem. But if high temperature performance is a problem to you, whether in present activities or in new projects, Inco High Temperature Engineers will do their best to help you. Let them send you the High Temperature Work Sheet . . . it is a big aid in getting the facts down clearly. Send for a copy now.



INCO
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Please send me the High Temperature Work Sheet so that I may outline my problem to you.

Name_____

Title_____

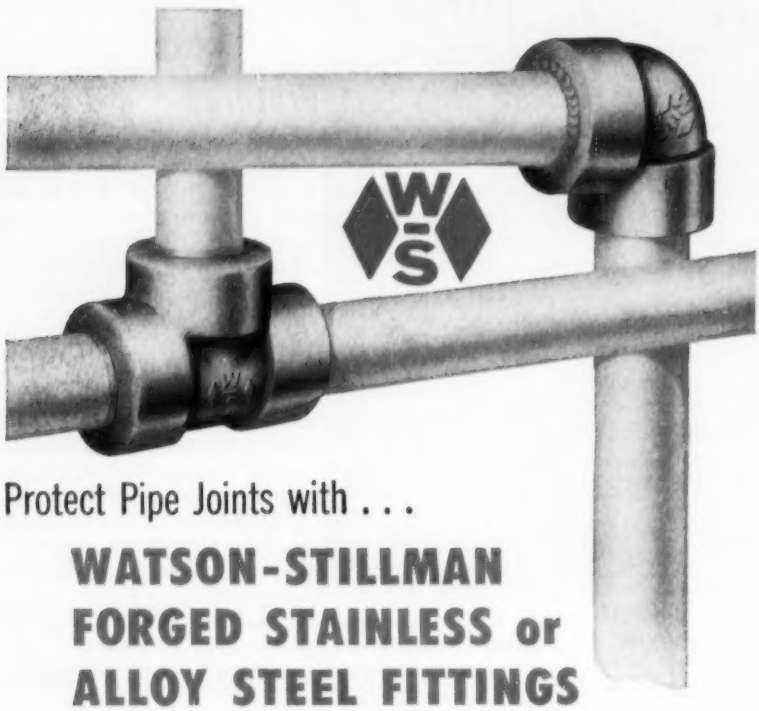
Company_____

Address_____

City_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

When **HEAT** or **CORROSION** Add to Your Pressure Piping Problems . . .



Protect Pipe Joints with . . .

WATSON-STILLMAN FORGED STAINLESS or ALLOY STEEL FITTINGS

IN CORROSIVE SERVICE your pipe joints take a beating—fluid velocity and turbulence accelerate corrosion wherever there is a change in direction of flow.

AT HIGH TEMPERATURES structural changes in the metal can cause loss of strength and subsequent failure.

Those are good reasons for "playing it safe" in high pressure service with W-S Forged Stainless or Alloy Steel Pipe Fittings. W-S Stainless Fittings resist corrosion in a wide variety of process liquids and gases and high temperature steam. Available in Types 304, 316 and 304 L.

W-S Alloy Steel Fittings resist oxidation and graphitization and retain their high strength in high pressure—high temperature steam lines. Three alloys available—1¼% Chrome-½% Molybdenum and 2¼% Chrome-1% Molybdenum and 4-6% Chrome-½% Molybdenum.

W-S Forged Stainless and Alloy Steel Fittings can be obtained in Screw-End Type for 2,000 lb., 3,000 lb., and 6,000 lb. WOG service; Socket-Welding Type for Schedules 40, 80, 160 and Double-Extra Heavy Pipe. Send today for bulletin S-1-55.

W-S FITTINGS DIVISION

H. K. PORTER COMPANY, INC.
Roselle, New Jersey

Who's Building . . .

ammonia and carbon dioxide from its neighboring ammonia plant. The new unit is due to go on stream in the fall of 1956.

Sun Oil Company has an alkylation unit under construction at its Toledo, Ohio, refinery. The unit, scheduled for completion by the last of April 1956, will use sulphuric acid as a catalyst to produce between 1400 and 1600 barrels a day of alkylate for blending into motor gasoline.

Texas Natural Gasoline Corporation, nearing completion on its Coke County, Texas, plan, is processing some 35 Mmcf. of gas a day. When completed, the plant will handle about 70 Mmcf. a day, turning out 800,000 gallons of liquid products. The Fluor Corporation, Ltd., has been in charge of engineering and construction.

Corpus Christi Refining Company has shut down its 7000-barrel-a-day Corpus Christi, Texas, refinery, for a $1,200,000 improvement and expansion program. The plant will be back in operation in June 1956.

Among the new facilities, due to cost some $560,000, will be asphalt-manufacturing facilities with an annual output of 200,000 tons, a visbreaking unit and expanded storage.

The company will add to and rework the existing vacuum unit, to process 3500 barrels of crude a day, upping the refinery's total capacity to 10,000 barrels a day.

New investments at the Corpus Christi refinery already have run to $640,000 since early 1955.

Anglo-American Exploration, Ltd., will spend $750,000 on expanding and modernizing its Hartell, Alba., refinery. Capacity of the 2500-barrel-a-day plant will be increased to 4500 barrels. New equipment will include a platinum catalytic cracking unit.

Monsanto Chemical Company plans to triple the production of vinyl-chloride paste resins at its Springfield, Mass., plant. Construction will begin immediately, with the new equipment expected to go on stream in the second quarter of 1956.

J. O. Buchanan and Company, Ltd., British refining concern, has started expanding its refinery, at The Wharf, Renfrew, to make a high-grade refined mineral oil with a by-product petroleum sulphonate. The company's new facilities are expected to go into operation early in 1956. Equipment already installed include a new distillation and extraction unit.

Esso Standard Oil Company will construct a $1,500,000 addition to its Esso Research Laboratory at Baton Rouge, La. The new addition will include high-speed electronic computing equipment, X-ray testing facilities and a section for nuclear experiments. Construction, to be completed by early 1957, will about double the plant's present laboratory and office space.

Solvay Process Division, Allied Chemical & Dye Corporation, has started operations at its new hydrogen-peroxide plant in Syracuse, N. Y. The plant in-

For more data on advertised products, use Readers' Service Cards, last page.

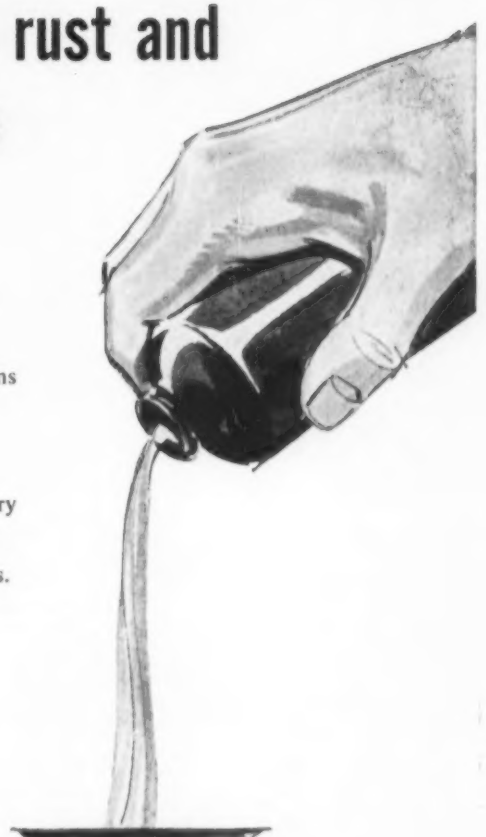
Pipeline protection from rust and corrosion costs so little with **UNICOR**®

The pipeline operators who use Unicor, UOP's oil-soluble corrosion inhibitor, not only get dependable protection but get it at surprisingly little cost. Such minute concentrations are required that Unicor's cost is only about $0.0005/bbl. of pipeline product.

Actually, only one molecule of Unicor is required for every million molecules of gasoline. Additional savings, too, from much reduced scraper cleaning and filter replacement costs.

Unicor is completely dependable. It prevents rusting in product pipelines at a typical concentration of 10 ppm. Addition is required at only one point and since it is distributed uniformly over the entire internal surface, protection is virtually 100% effective.

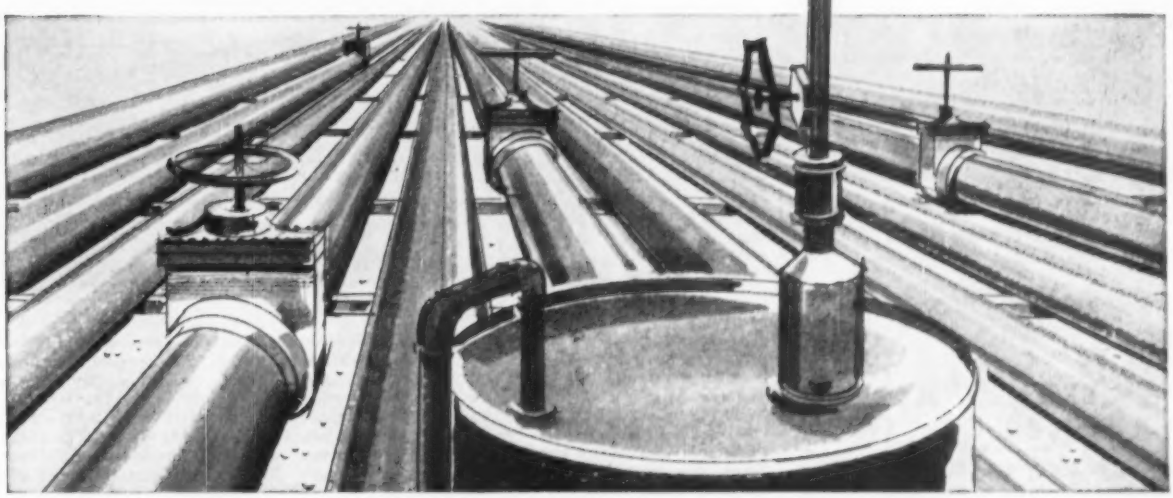
The services of our technical specialists are available to assist you in the design, installation and operation of a Unicor system of protection. Write us for samples and information.



PRODUCTS DEPARTMENT

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD
DES PLAINES, ILLINOIS, U. S. A.



For more data on advertised products, use Readers' Service Cards, last page.

NATIONAL AIROIL

Oil Burners

OF THE STEAM AND MECHANICAL TYPES NOW COMBINED INTO

Dual Stage BURNERS

Now, at last, the inherent advantages of *both* systems of fuel oil atomization are *profitably* yours . . . within the one, new NATIONAL AIROIL Dual Stage Burner.

45 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . . and, it has been thoroughly tested and proved in the field for firing: Petroleum Processing Heaters; Rotary Kilns; H.R.T., Scotch Marine and Water Tube Boilers; etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel oil from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

Get detailed descriptions, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNER
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, combining Steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
FURNACE RELIEF DOORS
AIR INTAKE DOORS
OBSERVATION PORTS
SPECIAL REFRACTORY SHAPES

Established 1912 — Incorporated 1917

NATIONAL AIROIL BURNER CO., INC.

1254 E. Sedgley Ave., Philadelphia 34, Pa.

Southwestern Div.: 2512 So. Blvd., Houston 6, Texas

Who's Building. . .

cludes units for synthesis, distillation and purification. It will turn out hydrogen peroxide in both 35 and 50 percent grades.

Standard-Vacuum Oil Company, negotiating with the Philippine government for construction of a refinery, is planning to put up a 20,000-barrel-a-day plant. The Shell Petroleum Company of the Philippine Islands, Ltd., also is planning to build a refinery. American Caltex Oil Company completed the islands' first refinery about a year ago.

Iranian Oil Participants, Ltd., has started up a 35,000-barrel-a-day catalytic cracker completed at its Abadan refinery four years ago. The cracker, shut down after its trial tests in 1951, has been completely overhauled and now is processing from a feedstock of wax distillate.

Petroleos Mexicanos has scheduled a $40-million expansion program for Tampico, to benefit the flood-damaged economy of that area. The program calls for installation of a new catalytic-cracking plant at the Ciudad Madero refinery and modernization of the Arbol Grande and Mata Redonda refineries.

International Petroleum (Colombia) Company, Ltd., has selected Bechtel Corporation to handle construction on its proposed 25,000-barrel-a-day refinery at Cartagena. The refinery, expected to cost some $35 million, is due to go some stream late in 1957.

Imperial Oil, Ltd., has awarded the contract for construction of a catalytic-reforming unit at its Montreal, Que., refinery. The new unit, with a daily capacity of more than 8000 barrels, will use a platinum catalyst to speed the reforming process. It will be built by The Fluor Corporation of Canada, Ltd.

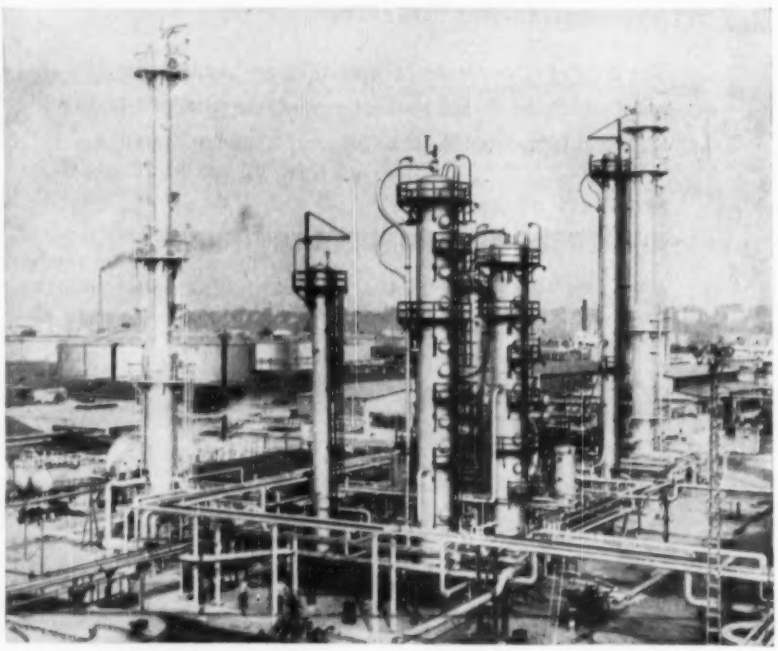
The new unit is the main item in a $4,500,000 refinery improvement program slated for Montreal.

Process designs were worked out by Imperial engineers, and Fluor will handle mechanical design. Construction will get underway by mid-summer, with the new reformer scheduled for completion by early 1957. The unit will be similar to one under construction at Imperial's Sarnia refinery.

Cia, Shell de Venezuela is planning a fourth distillation unit for its refinery at Cardon, where alkylation and catalytic cracking facilities already are under construction. The new unit, expected to cost some $20 million, will have a daily capacity of about 80,000 barrels. When completed, it will raise the capacity of the Venezuelan refinery to about 270,000 barrels a day.

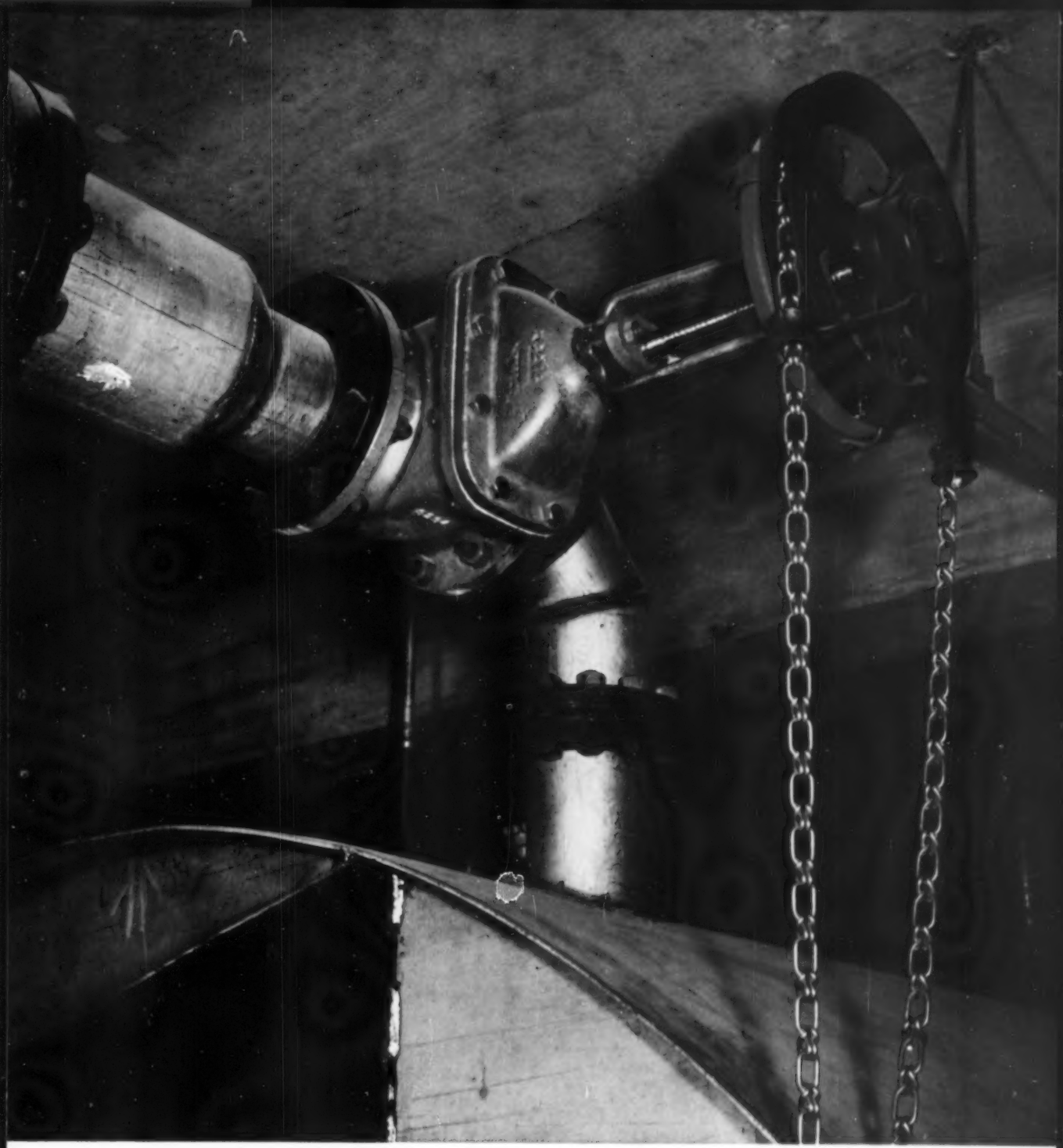
National Farmers Resources, Inc., will build an anhydrous-ammonia plant in Sanpete County, Utah, if a sufficient supply of natural gas is available. The company, affiliated with National Farmers Union, Denver, is planning a $12-million plant, with a daily capacity of 125 tons.

Phillips Chemical Company plans further expansion of its synthetic-rubber facilities near Borger, Texas, boosting the



Combination Units at Port Arthur—

Aerial view of the two combination Platforming-Unifining units at The Texas Company's Port Arthur, Texas, refinery. Each has a capacity of 20,000 barrels a day. The companion facilities are charging straight-run gasoline to produce reformate for use in motor fuel. Both can be operated on a blocked-out basis for producing aviation gasoline base stock. The Unifiners, which use excess hydrogen from the Platforming operations, pretreat feed stock for the Platformers. Construction of the two combination units was handled by The Lummus Company. Other such combination units are in operation at Texaco refineries in Amarillo and El Paso, Texas; Lawrenceville, Ill.; Casper, Wyo., and Westville, N. J. In addition, a subsidiary's Montreal, Queb., refinery is using this operation.



Film censor at work

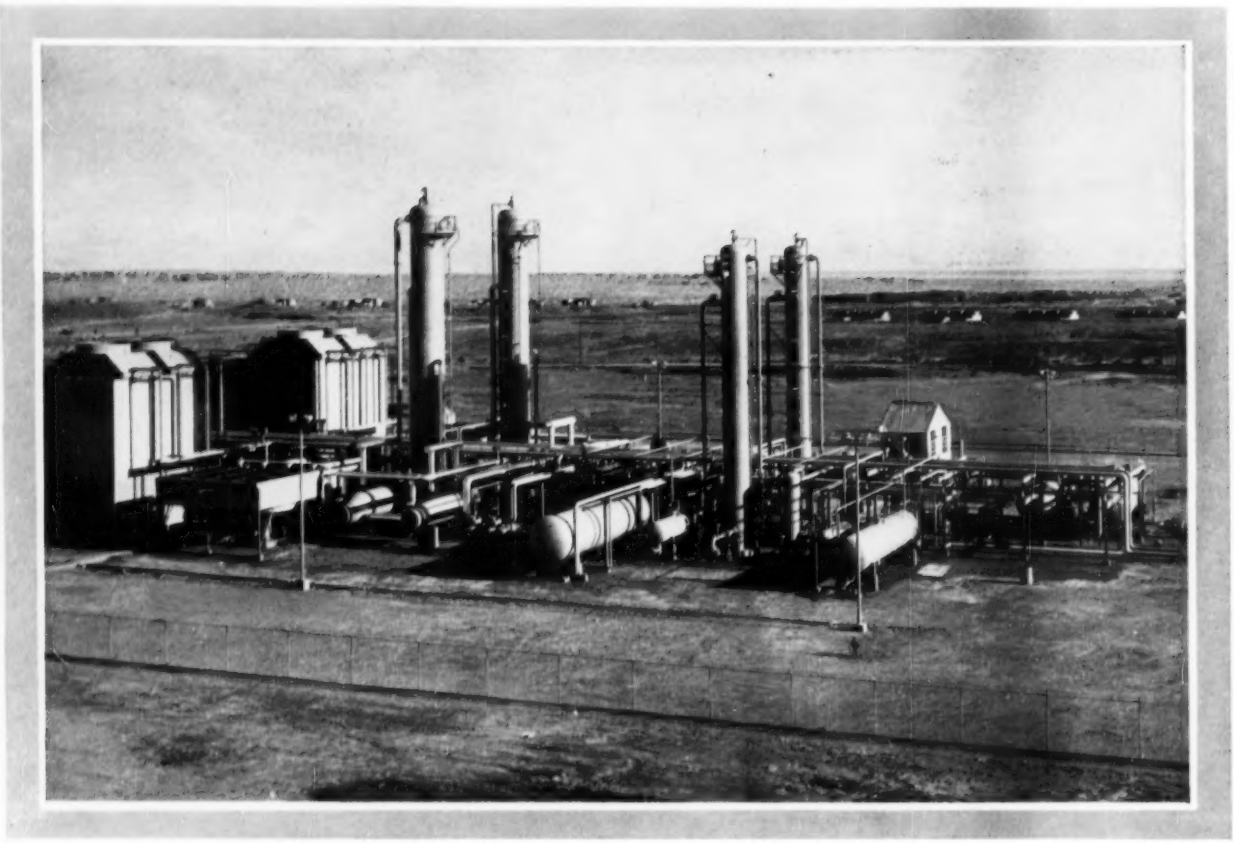
At 950-acre Kodak Park, the film-producing plant of Eastman Kodak Co. in Rochester, N. Y., they take no chances on film contamination.

For example, in the operation shown here, a red-wheeled Aloyco stainless steel valve rules out of the picture dangerous rust and iron contaminants which would spoil the thick fluid which is called "dope." These valves control the flow of dope onto roll-coating wheels, where solvents are driven off with heat. The dry film base is then readied for the final coat of emulsion.

Today thousands of industrial processes are being safeguarded by Aloyco corrosion and contaminant resistant valves. Find out why their dependable performance makes them first choice for all types of vital flow lines. Write Alloy Steel Products Co., Inc., 1301 West Elizabeth Avenue, Linden, N. J.

Longer Lasting
ALOYCO
VALVES
SET IN CORROSIVE SERVICE

Subsidiary of Walworth Company

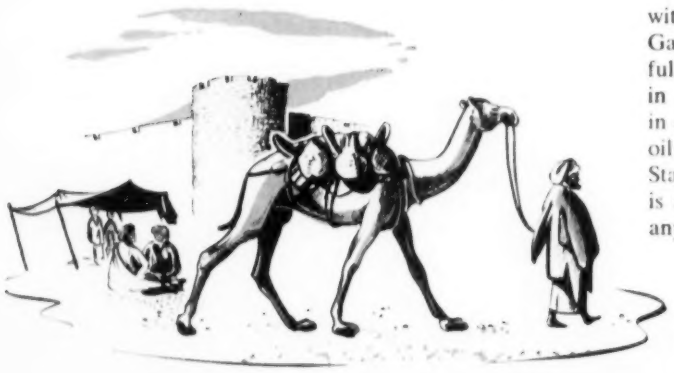


Sui GAS STARTS TO KARACHI

This plant, the first of its kind in Asia, is located in the Sui Gas Field 350 miles northeast of Karachi in West Pakistan. It processes sour gas, removing sulphur compounds and water vapor, preparing the gas for transportation and consumption. It is a vital part of a project from which will accrue great economic advantage to Pakistan.

The work of Hudson included design, procurement of equipment, transportation, and erection using English, American and native labor.

Despite the remoteness of the plant site, the rail terminus being 40 miles across the desert, and air temperatures as high as 125 F. in the shade, the plant was completed in 12 months from start of design work.



Hudson is proud to have collaborated with Pakistan Petroleum, Limited, and Sui Gas Transmission Corporation in the successful completion of this first project of its kind in Asia. The experience of Hudson gained in over 30 years in design and construction of oil and gas processing plants in the United States, Europe, Mexico and South America is available for any project large or small in any part of the world.

HUDSON

ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

Who's Building. . .

copolymer plant's annual rubber-making capacity more than 50 percent, or 30,000 long tons over its present 57,000 tons.

Production of the adjacent butadiene plant will be raised by 24,000 short tons a year, to provide the needed extra butadiene supply. The company is a wholly-owned subsidiary of Phillips Petroleum Company.

Magnolia Petroleum Company has a $25-million expansion of its Beaumont, Texas, refinery scheduled for 1956. New construction at the 180,000-barrel-a-day refinery will include:

- A 28,000-barrel-a-day Thermofor catalytic-cracking unit, which will be the world's largest.
- A vacuum-flash unit to prepare oil stock for the new TCC.
- A 20,000-barrel-a-day Sovaformer unit to process naphthas into 100-plus octane gasolines.
- New facilities for processing LPG.

Raffinerie Siciliana Oilli Minerali intends to increase the capacity of its Augusta, Italy, refinery to 2,150,000 tons a year. The plant's present thruput is about 650,000 tons.

National Petroleum Corporation of Cuba is planning construction of a new oil refinery in Cuba. Due for completion late in 1956, the plant will be the island's third new refinery to go on stream about that time. It will be built at Port of Cienfugo, with a daily capacity of 5000 barrels. The company, formed by a group of businessmen in Cuba and Florida, will build a $10-million installation.

The other two plants will be Texaco and Shell refineries. The Texas Company (West Indies), Ltd., has started construction on a 20,000-barrel-a-day refinery at Santiago, and Cia. Petrolera Shell de Cuba has a refinery under construction near Havana. The Shell plant will have a 25,000- to 30,000-barrel-a-day capacity.

U. S. Rubber Company will build a new chemical plant for the production of plastics. The plant, at Baton Rouge, La., will be operated by the company's Naugatuck Chemical division. Construction of the $5-million plant will be started immediately, with completion expected by July 1957. The plant's output will be a copolymer based on styrene, butadiene and acrylonitrile.

Clark Oil & Refining Corporation, in 1956, plans to spend $1,750,000 to increase the capacity and efficiency of its refining facilities. The company operates refineries in Chicago and New Orleans.

Greek Government has started construction of its 30,000-barrel-a-day refinery at Piraeus. The refinery, the country's first, is scheduled to go on stream early in 1957. It will cost some $15 million to build.

Three German firms are participating in the construction. They are F. R. Krupp Machinen und Stahlbau Reinhausen, Stahlunion Export, GmbH., and Hydrocarbon Mineraleol, GmbH.

Hydrocarbon Research, Inc., is handling the engineering, and another U. S. concern, George Armistead and Company, is serving the government as a consultant.

PIPING LAYOUT IS SIMPLER with

...THEY NEED SO LITTLE ROOM

Gentile Flow Tubes are short. They need only minimum straight runs entering and following, and can be installed at practically any accessible point where flow conditions are reasonably steady.

Flow Tubes are furnished with individual head capacity curves, and for unusual piping arrangements, calibration curves for simulated conditions can be furnished.

Guaranteed

- Accuracy
- Minimum Head Loss
- Reproducibility

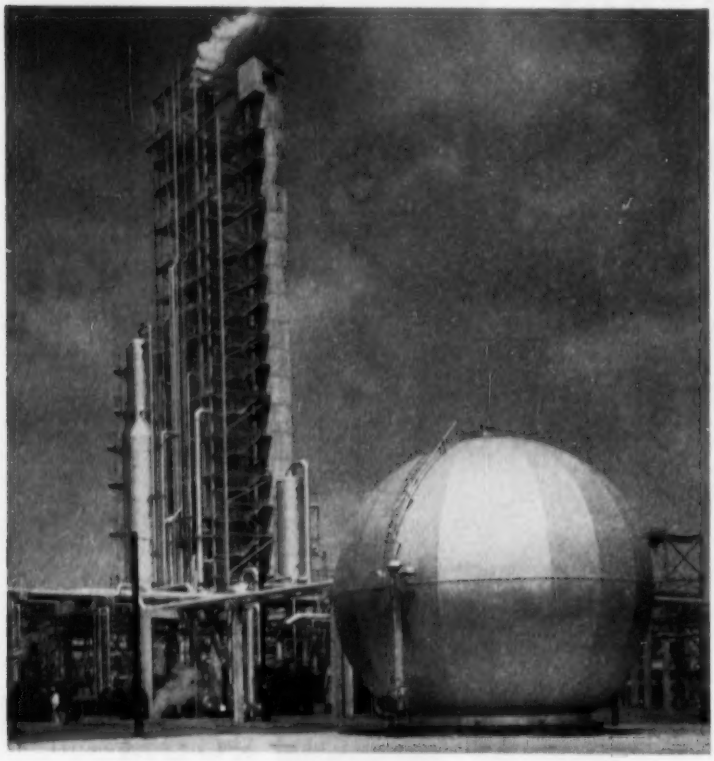
*GEN-TIL-LY

FOSTER ENGINEERING COMPANY

835 LEHIGH AVENUE UNION, N. J.

AUTOMATIC VALVES • CONTROL VALVES • SAFETY VALVES • FLOW TUBES

For more data on advertised products, use Readers' Service Cards, last page.



Thermofor catalytic reforming unit at General Petroleum Corporation's Torrance, Calif., refinery.

Socony Mobil Expansion . . . *continued from Page 99*

was considerably expanded, and present output is around 110 tons a day, part of which is for the company's own use and part for use in licensed TCC units or other catalytic cracking processes. TCC catalyst is manufactured in Europe by Kali-Chemie A. G. at Nienburg, Germany, under Socony Mobil license.

To meet the postwar challenge of its competitors for gasoline markets, Socony Mobil has developed two catalytic reforming processes for improving gasoline quality. The company's Thermofor Catalytic Reforming (TCR) process produces large yields of high octane number gasoline from a wide range of feed stocks, including thermal naphthas and those very high in sulfur. A second process—Sovaforming—employs fixed-bed reformers using platinum catalyst and is designed primarily for reforming low octane straight-run stocks.

The chrome-alumina bead catalyst used in the TCR process is manufactured by Socony Mobil at Paulsboro. The TCR bead plant was brought into full operation in 1954 and by the end of that year had a rated capacity of five tons a day.

During 1955 TCR units went on stream at Socony Mobil's two largest domestic refineries—at Beaumont, Texas, and Torrance, Calif. Sovaformers were on stream at two other plants—Ferndale, Wash., and Augusta, Kan. Five other Sovaformers were under construction at East Chicago, Ill.; Paulsboro, N. Y.; Trenton, Mich., Beaumont, Texas, and Buffalo, N. Y. Work on additional units at domestic refiners will begin this year. Overseas a Sovaformer went on stream last year at Gravenchon, two others are under construction at Coryton and Bremen, and units are planned for Frontignan and Naples.

Despite the impressive construction record of the last decade, Socony Mobil plans an even larger effort during the next few years. In the three year period 1956-58 the company has budgeted substantially more for new manufacturing facilities than in any three-year period in its history. A total outlay of $232 million is planned for expansion and improvement of processing facilities at existing domestic refineries and expenditures of $35 million are budgeted for construction at European plants.

Outlays of this magnitude are required in part to expand facilities in order to supply greater sales but they are primarily caused by the continuing need for higher quality products both at home and abroad.

By the end of 1958 Socony Mobil expects to have total catalytic reforming capacity of 150,000 barrels a day at its U. S. refineries. To make possible still further improvement in gasoline quality, the company plans to build four additional alkylation units at domestic refineries during the next three years and to expand five such units.

Socony Mobil also plans to begin construction this year of several new units for improving the quality of distillate fuels. A contract has recently been awarded to Foster-Wheeler Corporation for construction at the company's Paulsboro, N. J., refinery of the first of these units, which will use a catalytic desulfurization process, called Sovafining, developed by the company's Research and Development laboratories.

Similar units will be installed at all five major Socony Mobil refineries in Europe in the next three years, as well as in a number of domestic plants.

In addition to new equipment for improving product quality, the overall capacities of four domestic refineries will be increased during the next three years by the construction of new crude distillation units or the enlargement of existing units. Additional coking capacity is scheduled for construction at several domestic refineries. Sulfur recovery plants also are planned for Beaumont and Paulsboro, as well as for Coryton and Bremen overseas.

A substantial increase in the crude capacity of Socony Mobil's European refineries is contemplated in the 1956-1958 period.

Socony Mobil's management believes the planned construction program at home and abroad will enable the company to keep pace with the most efficient of its competitors in the refining industry. ##

TODAY'S LESSON...

Blend WARREN NATURAL GASOLINE with your present high quality motor fuel to give it...

RETAINED VOLATILITY

...in any Season!

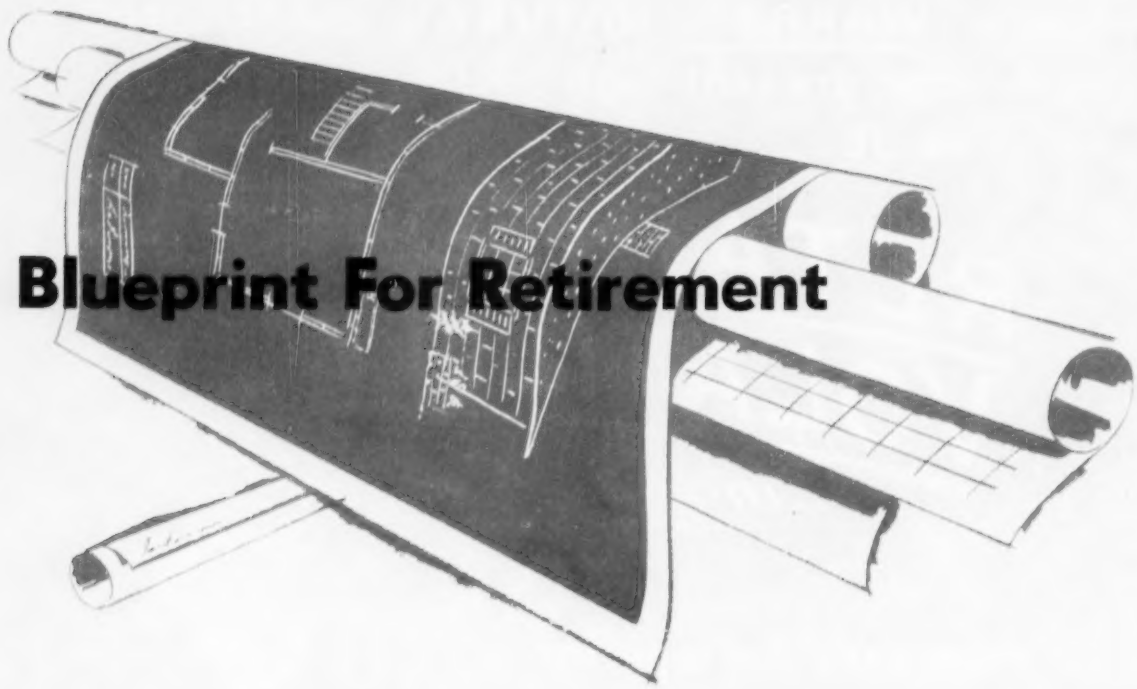
So necessary for superior performance after it reaches your customers' fuel tanks!

WARREN

PETROLEUM CORPORATION

TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN

EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARRENGAS, (HOUSTON) TEXAS; SAN PEDRO, CALIF.



Blueprint For Retirement

Shell's planning-for-retirement program is starting employes to thinking about the future.

THE JOB was Jim Brown's life. He had few friends outside the company and no interests other than his work.

After retirement he rented an office. He now does a regular nine-to-five stint at his desk attending to personal affairs and a small dribble of correspondence. He has no telephone. No official business connection.

"I don't put in an honest day's work," he admits, "but this is all I have to keep me occupied."

"The greatest mistake I ever made was to retire 'cold'."

This is the case history of a man who failed to plan for retirement. The same story is repeated—in one form or another—thousands of times every year. In fact, one large oil company recently found that among 722 employes of retirement age:

53 percent were anticipating retirement, few of whom had plans for the future.

32 percent were indifferent—had made no plans.

15 percent actually resisted retirement.

Another oil company reports that only one out of 25 of its employes has given serious thought to retirement. The rest are facing a problem similar to Jim Brown's.

What is the oil industry doing to prepare its employes for retirement?

An excellent example is that of three companies—Shell Oil, Shell Chemical and Shell Pipe Line. They established a "Planning for Retirement" program on a trial basis in 1952. It matured in 1955 when pre-retirement discussions on a voluntary basis were made available to employes in nearly every Shell location.

Before establishing the program, Shell officials determined that post-retirement difficulties vary with individuals and different types of jobs. Readjustment may not be as simple for refinery workers as for drilling, producing and pipe line people in the field. Chances are the latter will stay put in the small communities in which they have been working—where they have established strong social ties and perhaps have purchased a little land or become otherwise rooted.

But the refinery worker, having spent his working years in the hustle and bustle that surrounds the larger plants, is more likely to long for the peaceful rural life. He is the man who will benefit most from a sound com-

pany retirement program.

Shell found that the situation is not so acute with women employes. Most of them plan to return to housekeeping.

Framework of the Program. Once the need for the retirement-aid service was determined, Shell selected employes experienced in personnel matters to handle the program. They were trained in all aspects of retirement and its problems. As more workers were trained for the job, they spread out to such widespread operations as exploration and producing areas. Men conducting the program in these areas often travel great distances to employes seeking the service.

Herbert Leasure, of Shell's head office personnel department helped establish the program. He now assists in coordination throughout the Shell organizations.

"We offer information on a variety of subjects," says Leasure, "but a lot of times we just serve as good listeners, because many people need nothing more than an opportunity to talk out their own accumulation of thoughts about retirement."

Leasure points out that given an opportunity to talk, an employe's ideas often fall into place in an orderly pattern for future action.

The first goal of the men handling the retirement interviews is to get an employe started *thinking* about retirement and what it involves. If an individual has any ideas or opinions about what he should do after retirement, it is up to the retirement consultant to help explore them and determine if they are practicable.

Company officials are quick to point out that they do not tell anyone how to spend his time or money. Stimulating thought is the big aim. Once interest is generated, the employe will develop his own plans.

How the Program Works. Employe participation is strictly voluntary. At each location, the manager sends a personal letter to the employe approaching retirement age. This letter merely reminds the employe that the service is available. Those who indicate a desire to participate are then invited to sit down in private and confidential discussions with the person handling the program.

Four discussions, usually spread about two months apart, take up specific retirement problems. The employe's views or plans concerning these problems are dwelt upon. The employe is under no obligation to attend the discussions.

The first talk covers the general purpose of the "Planning for Retirement" program. The desirability of planning and what to plan for are explained.

The second discussion deals with finances, company benefits, social security, etc. It has been found that many employes have little knowledge of their company retirement plans. A check list is also provided to help the employe determine the nature of the important papers and records he has, where they are kept and where to go for advice concerning such matters as insurance policies, stocks, bonds and real estate.

The third session usually deals with health and physical condition. A physical examination is provided at company expense. The employe may use either a company doctor or a doctor of his own choice. This phase of the program is mainly to encourage periodic physical examinations. The company keeps no record of the examination. However, it does give the person facing retirement some idea of his physical limitations, if any, which should be considered in planning activity after he leaves the company.

The fourth discussion concerns problems which the employe may have discovered during the three previous meetings. This session also covers where to live and what to do during retirement.

In addition to the interviews, each participant in the program is given an outline of the service, a series of articles dealing with retirement and a bibliography of books and magazines devoted to the many different aspects of retirement.

Benefits of the Program. Shell's retirement-aid program is still in the embryonic stage. Counselors are working with veteran employes who are within a year or so of retirement. The eventual plan is to contact every employe five years before he reaches retirement age. However, tangible results already are beginning to show:

- The discussions gave a shift foreman the idea that he could get closer to his favorite hobby by purchasing a fishing lodge. He is now happily engaged in his own business.
- A retired pumper, who had hunted quail all his life, is now raising quail for commercial purposes.
- A stenographer purchased a large house and made a duplex out of it. She recently added a garage apartment. Her business venture—resulting from the discussions—has proved both profitable and interesting.

Retirement Counselor J. E. James of Shell's Houston office describes the program in the following manner:

"It is not a counseling service in the truest sense of the word, outside of the financial aspects. I see it as an opportunity to ask our people four times a year . . .

". . . Do you have a 'blueprint' for retirement?"

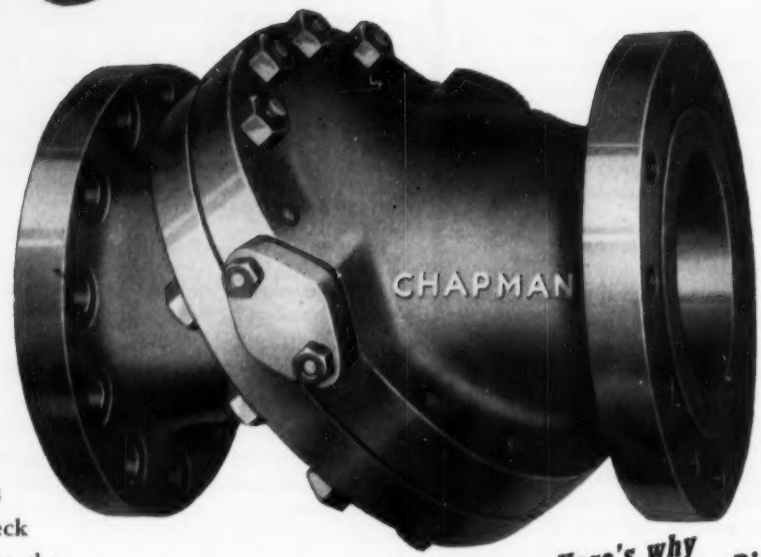
Facing this one fact can mean the difference between a happy and an unhappy retirement. ##

Seven Steps to Happy Retirement . . .

1. **Plan your investments with an eye toward retirement—save part of what you earn.**
2. **Decide what you will do with your time after retirement—start preparing for it before you retire.**
3. **Develop the right mental attitude.**
4. **Have a home paid for by the time you retire.**
5. **Protect your health.**
6. **Make lasting friendships.**
7. **Take active interest in church work, civic affairs, politics or similar activities.**

Only Chapman Tilting Disc Check Valves give you

FAST TIGHT QUIET CLOSURE



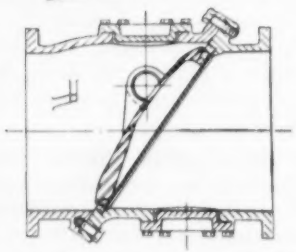
Fast, quiet operation means low cost operation for check valves. That's exactly what the Chapman Tilting Disc Check Valve is designed to do. It won't flutter or slam and damage the piping joints or the valve itself. The unique drop-tight closure action eliminates scraping and wear of the disc and seat.

Rugged construction and low wear of the Chapman Tilting Disc Check Valves mean long life under severe operating conditions. Absence of vibration plus low head loss keep maintenance of the entire piping system at a minimum.

Whether for replacement or for new piping systems, be sure to specify Chapman Tilting Disc Check Valves. They're available in iron and steel for handling fluids or gases under a wide range of pressures. For full data on the complete line, write today. Ask for Catalog 30-A.

The Chapman Valve Mfg. Co.
INDIAN ORCHARD, MASSACHUSETTS

Here's why Chapman's Tilting Disc Check Valves Keep Quiet All of Their Lives



This specially designed "airfoil" disc balances perfectly in open position. The fluid holds the disc tightly against its stops without flutter. The body of the valve is larger around the disc, so the net valve area is at least as much as the pipe area to assure low flow resistance.

When the flow is reversed, pressure against the uppet part of the disc cushions it as it closes. Then the disc drops easily and tightly to its beveled seat after the valve has swung closed. Seating is fast and quiet with minimum head loss in all but unusual piping arrangements.

For more data on advertised products, use Readers' Service Cards, last page.

As Management Sees It . . .

Mold Your Own Leaders

Here is a program that will help you train industrial management groups . . . qualified to take part in top-drawer decisions.

W. L. Linton
Mountain Lakes, New Jersey

TODAY'S INDUSTRIAL management is usually done by groups of people. How do such groups acquire the necessary knowledge and judgment to do the job? To do it adequately requires experience, training and foresight.

The making of decisions is the main consideration of any sound management group. The most important decision is the selection of the proper people to administer the key jobs. The next real concern is to make certain that these people continue to grow in wisdom and intelligence.

The development of an industrial management group can be accomplished within any plant without interfering with the work schedule. Few, if any, outside specialists should be hired to conduct the course.

7 advantages of decentralization . . .

1. **Encourages the individual to use initiative**
2. **Helps self-improvement as people learn to think constructively**
3. **Unfolds a feeling of pride in belonging to an organization**
4. **Fosters better adjustment to work situations**
5. **Builds self-reliance and personal integrity**
6. **Reduces management lines to a minimum**
7. **Improves communications between levels of management**

Prerequisites for Program

1. Make certain the participants in the group desire such a program.

2. Top management must provide a pleasant, comfortable, cheerful place in which to meet. No telephones should be in the room. An efficient, tactful secretary in an adjoining room is highly desirable to handle any telephone calls. The outside jobs held by the participants in the meeting should be covered by an assistant or a person who might be considered good material for future assistants. Good training for both, it can be added.

3. Top management must be willing to be patient in looking for the end results. One year makes the group a more creative and expressive one. However, unless management is willing to plan a series of courses which lasts several years, it had better forego the program.

Organization—Personnel involved in this presentation includes the management group of an oil refinery with some 600 employees. The group is further subdivided into: (1) A planning committee, (2) foremen, (3) assistant foremen with department assistants, and (4) project engineers. This alignment is best as it is advantageous to have people on the same level of responsibility sitting about the conference table. They are more apt to be less restrained in their conversations and opinions if they share similar levels of authority. It also develops group pride—a valuable asset in any plant organization.

The planning committee is composed of the manager, his assistant, department superintendents and staff (the heads of safety, industrial relations and accounting). This group does most of the future planning and accounts for the monthly progress, department-wise, in completing the annual program (objectives) of the refinery. This program should be prepared by the superintendent or department head and finally approved by the committee.

Each of the latter three groups meets about every three weeks from

Industrial management by key groups . . .

- **Reduces errors in making decisions**
- **Inspires keener forward planning**
- **Makes better schedules for handling the immediate work load**

September through May. If the allotted two hours for a meeting happens to be insufficient, another meeting is scheduled in two weeks time. If the pressure of business delays a scheduled meeting, it can be postponed and the time made up when it is convenient. The planning committee meets on a regular schedule once a month to review the P. & L. for the proceeding month and make the necessary plans for the week ahead. This meeting could last as much as four hours. In all but this committee meeting, a member of the group acts as chairman, with a gavel, and another takes notes from which the minutes of the meeting are published. These meetings are conducted in business-like fashion with everyone present taking part in the discussions and conclusions.

Meet the Author

W. L. LINTON recently retired after 18 years as manager of the Socony Mobil Oil Company, Inc., refinery in Brooklyn. He joined the company as a research chemist in its Brooklyn laboratories in 1920, shortly after completing his doctorate at Johns Hopkins University. Dr. Linton served in the laboratories 12 years before he was named to head what is now Socony Mobil's Technical Services department. He had been in charge of that operation nearly eight years when, in 1938, he was appointed superintendent of the company's Sone & Fleming works. Later, he was given the job of consolidating the company's refining operations in the New York area and reorganizing the Brooklyn plant.

Context of Meetings—Groups 2, 3 and 4 devote one meeting in three-month intervals to a discussion and reporting on an individual basis, their participation in the Plant Cost Reduction effort and Plant Annual (objectives) Program. This is an accounting of their stewardship—a most effective means of training members of any management group.

The other meetings are devoted to a variety of topics, designed to arouse a better concept of what is required to be a part of management. These topics include duties of foremen, personnel relations, (including union representatives) civic responsibilities, selection of personnel to do a job best, the craft development program, yields, quality of product, and plant profit or loss.

The meetings for the department superintendents and foremen have existed for a number of years. The meetings for the assistant foremen and project engineers are but three and two years old respectively.

The planning committee has a membership of nine and the other groups vary from 12 to 16. The spirit of the meetings is contagious and enthusiastic with a full interchange of ideas and opinions.

Heart of the Program—The most important aspect of the program is the study group consisting of a panel of four people, one each from the planning committee, foremen, assistant foremen and project engineers groups. During a typical study meeting the subject of decentralization was covered in the following manner:

- The plant manager talked about decentralization in terms as defined and described generally by authors of recognized ability.
- The member from the foremen's group discussed the application of decentralization in one of the larger corporations.
- The member from the project engineer's group discussed the topic as it was practiced in his own company.
- The member from the assistant foremen's group expressed his analysis of how decentralization was being applied in the local plant.

A member of the industrial relations group capably acted as a monitor for each meeting. Three of the panel group were college graduates, one of whom had completed some post-graduate work. The assistant foreman was a high school graduate who had plenty of interest in improving himself by reading, studying and listening to others. The quartet presented their topic at the meetings of the foremen, assistant foremen and project engineers groups respectively. The presentation was given in one meeting and parts of it repeated if necessary. At the meeting following the final summation, a rebuttal team of four was selected from each of the three groups to tear apart what had been presented at their own meeting. This, too, could be at one or more meetings.

The study groups proved most enjoyable to the participants and to give an example of how successful these meetings were, it need only be mentioned that discussions were continued back on the job and during lunch time. At the last two meetings of the year another team of four from each group gave a summation of what they understood was intended by the panel on each topic and exactly what benefit, if any, was derived from them.

Three other subjects—Communication, Personnel Development, and Appraisal and Automation were presented similarly. The first was given by another panel composed of the assistant plant manager and a member from each of the three groups mentioned. A department superintendent and the chief project engineer headed two other panels of four people. The preparation of subjects entailed assistance from headquarters and a study of how each subject related to the local plant.

One of the most important results obtained in this respect was a thorough analysis of how each topic could be applied to better local conditions. In certain cases, it was found that current practice was entirely satisfactory after a realistic review. There was no question but what each subject when properly applied locally, materially improved the adaptability of each group toward their fitting into a more useful part of the entire management group. Other topics will form a program for next year.

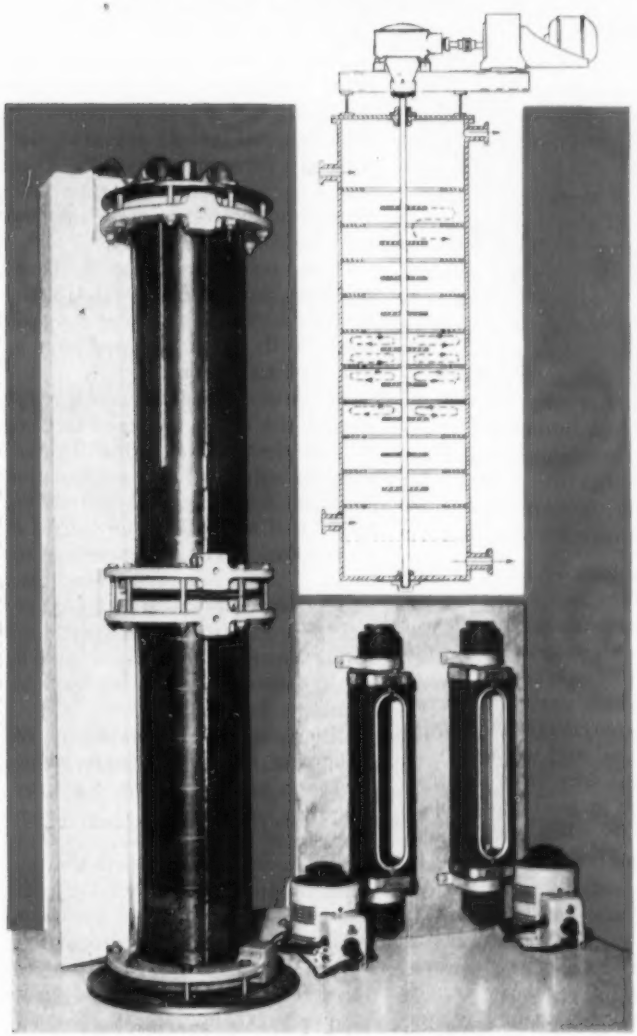
Advantages of Program—The advantages of such a procedure are several. Anyone who is apt to get into a rut by thinking what is being done locally is the alpha and omega of his endeavors is due for a rude and ultimately healthy awakening. The application locally of improvements in policy and management practices results in increased earnings by broadening the perspective of each individual in every group. Current local

Turbo-Topics

TURBO-MIXER GENERAL AMERICAN

TURBO-MIXER, a division of

GENERAL AMERICAN TRANSPORTATION CORPORATION



Demonstration model—used to show how the R.D.C column actually operates

Turbo-Mixer R.D.C.* Column

Rotary Disc Contactor for Liquid-Liquid Counter-current Extraction

Six years of data and design development in the laboratory, pilot plants and industry have demonstrated the superior features of this practical counter-current and gravity flow extractor. The R. D. C. extractor offers:

1. **high volumetric efficiency**
2. **high throughput capacity**
3. **simplicity of construction**
4. **no interstage or external settlers**
5. **low power requirements**
6. **flexibility of operation**

May we assist you in the solution of your extractor problems? Our laboratory facilities are available for evaluation of your extraction system.

**Licensed under Shell Development Company patent*

SALES OFFICE: 380 MADISON AVENUE, NEW YORK 17, NEW YORK

General Offices: 135 S. La Salle St., Chicago 90, Illinois • Offices in all principal cities

OTHER GENERAL AMERICAN EQUIPMENT:—DRYERS • EVAPORATORS DEWATERERS • TOWERS • TANKS • PRESSURE VESSELS

For more data on advertised products, use Readers' Service Cards, last page.

practice in all four subjects was carefully and critically reviewed and if not changed, surely justified the belief that such must be acceptable for the time being. Of course, the immeasurable value of each participant believing he is a part of the plant management lends itself to improve his own record.

As a result this particular management group is eager to be more useful in bettering the plant's realization. Woe be unto him who does not think through problems enough and disrupts such goals being attained. The plant manager on one occasion had to take some ten minutes to explain to an assistant foreman why it was necessary to re-handle a shipment of catalyst.

All of the groups learned to plan their work better and above all "get the job done." If there had been a certain reluctance to express one's thoughts and ideas lest it might incur some displeasure of one's immediate superior, this rapidly disappeared. One example was that of a mechanical foreman who made a suggestion which reduced the down-time for inspection of a distillation unit from five to three days. This was done over the expressed skepticism of people one layer of management above him. The results converted the doubters and gave the suggestor encouragement to make other valuable contributions toward increasing plant profit. You can rightfully argue that this is what a foreman is supposed to do. However, this and many other illustrations were prompted by an initiative which had been too dormant in the past. Now, it is fun to make suggestions at this plant—no matter how wild they first sound.

The participants in the meetings of the three groups summarized what benefits they personally had acquired from the lectures and discussions. These are believed to be forthright expressions from realistic and enterprising industrial people. Some with formal education, others reaching their positions by being leaders, but all of them developed their ability to exercise good, sound judgment. A brief summary of thoughts developed from the several topics follow:

Decentralization

1. Extended use of departmental meetings of key personnel. This enables the group participants to know why certain jobs are scheduled and what has to be done when, by whom and why.
2. The delegation of authority is broadened.
3. Plant staff people are asked for more information on accounting, safety, personnel and policy matters.
4. Costs are reviewed minutely and accountability is impressed upon everyone.
5. Clearer knowledge is had of job duties—these should be increasing from year to year in the lower echelons as decentralization matures and craftsmen and operators develop their abilities.
6. One of the main advantages comes from more efficient planning, including the scheduling and control of operations.
7. Increases the degree and variety of training of those at the lowest management level. There is plenty of evidence that greater personal confidence is nurtured when people are "on their own," not to mention an enlargement in job and morale satisfaction. There is no question but what decentralization develops initiative and incentive by demanding greater capacity for thinking accurately, Also, changing conditions are coped with more competently.

Communications — This rather complex subject will become more useful when the communicator learns to live up to his responsibility and people begin to comprehend with understanding. There are many means of providing information on what needs to be done, and we are struggling to give the why of it. Controls are wrapped up in good communications, especially when one or more shops or sections become involved.

Interdepartmental communications seem to be the most baffling. Whether this is due to an uninformed personnel, vague instructions where conciseness is indicated or a method of policy matters little, there is ample room for improvement. Of course, the stake is a lucrative one, since time can be saved and higher grade work can be completed if one communicates properly.

It was, to be sure, quite obvious to these groups that better communications meant more effective planning in the use of manpower. The best scheduling of the use of equipment is attained by communicating properly. Also, it provides for an adequate supply of material being available when needed. The importance of good communications can not be stressed too much. There are many ways of communicating and more will emerge in the years ahead. If those concerned grasp the importance of this subject, gratifying increases in plant profit will be forthcoming.

Employe Evaluation and Appraisal—This subject found a lot of enthusiasm among the groups after they fully understood how the procedure functions. The participants wanted to make certain they were being judged by people who were qualified. Also when improvements in their personal records appeared, they wanted it recognized promptly. There was a keen desire to become more competent and frank personal reviews were welcome.

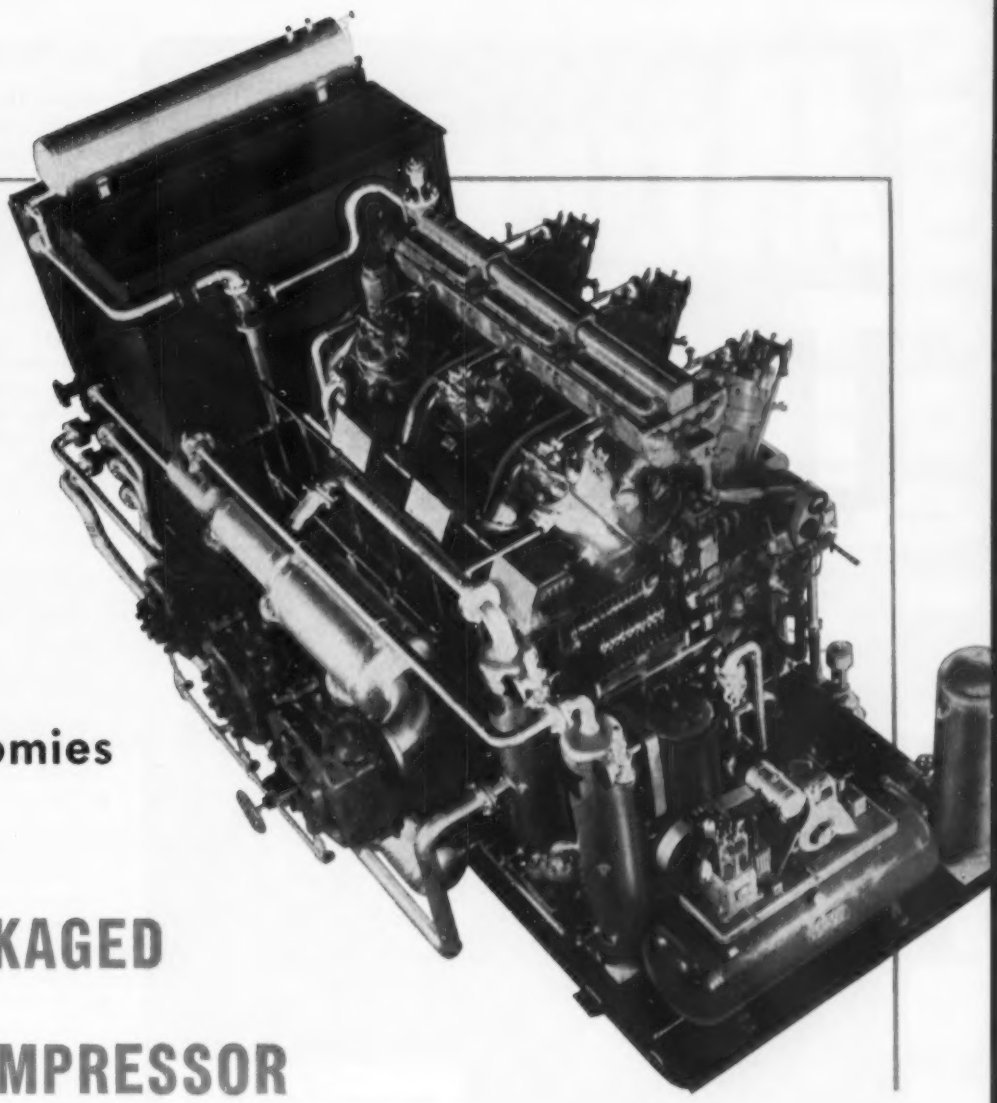
It was pointed out that the better employes did their jobs PLUS and were aware that the area of responsibility for their own job need have no iron-clad restrictions.

An interesting skit was staged by two of the newer assistant foremen as they described a "gripe" by one, with the other informing him that based on what he had heard, the griper had no cause to be fearful of his reputation with his immediate superior. The griper's superior had been heard to express himself as being very well pleased with the conduct of his subordinates. The griper said he would much prefer getting such information first hand.

Other skits were portrayed by this group and all of them were wholesome and helpful. There is a suspicion that some of the skits taught members of top management a thing or two, proving that decentralization works up and down the level of command.

The participants also learned that a person's record is a most tangible thing. Results can be counted up as one produces. However, it is not advisable to depend too much on a set of words, such as personality, agreeableness, dependability, diligence, etc. They can help, but many of our famous men were wont to "daydream" and would have made a sorry showing by answering some of the tests popularly supposed to classify

Another Example of Efficient Power at Lower Cost



NOW...

new economies with the

NEW PACKAGED GMXD COMPRESSOR

● Completely pre-assembled, mounted on a skid base, and available for fast delivery . . . the new Cooper-Bessemer GMXD packaged compressor is ready for economical pressure maintenance, gas lift, and all similar services.

With the packaged GMXD, you benefit from the many advanced engineering features of the unique Cooper-Bessemer V-angle design. In addition, the GMXD offers lower peak firing pressures and reduced exhaust gas temperatures, higher scavenging air ratios to all loads, high allowable compressor piston rod loading, small space requirements per horsepower and ample working space around power and compressor cylinders. Moreover, a new high in smooth-running balance has been achieved permitting unmatched performance under previously "impossible" conditions.

For fast service and delivery . . . in the heart of the oil and gas country . . . packaging of the GMXD is handled in Texas, Louisiana, Arkansas and New Mexico by Southwest Industries, Inc., Houston, Texas. Detailed bulletins, helpful planning information or quotations can be obtained from Southwest Industries or any Cooper-Bessemer office.

MOUNT VERNON, OHIO

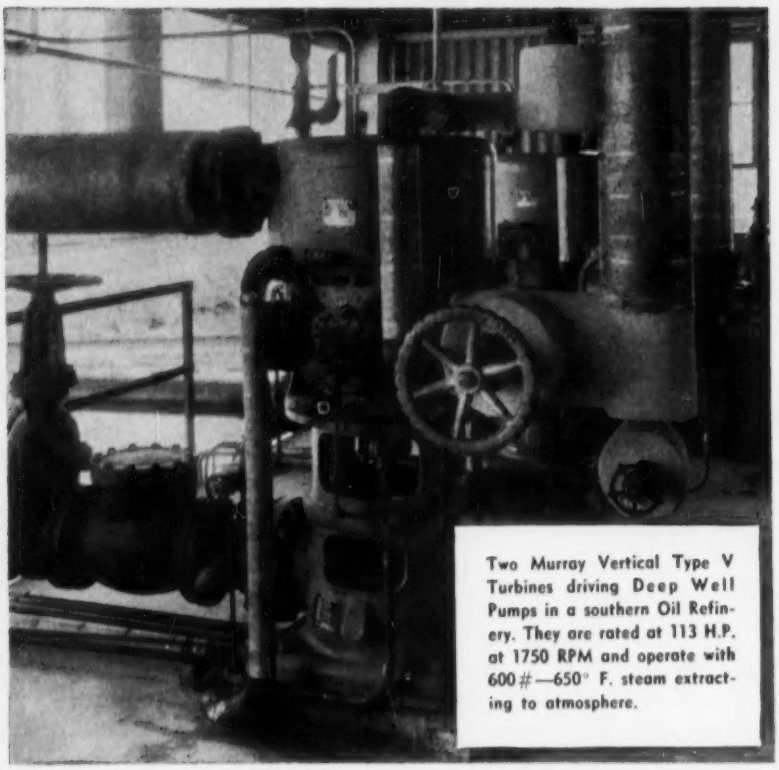
COOPER-BESSEMER

GROVE CITY, PENNA.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. Houston, Dallas, Greggton, Pampa and Odessa, Texas Washington, D. C. • Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. • Cooper-Bessemer of Canada Ltd., Edmonton, Alberta—Halifax, Nova Scotia.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

Murray Turbines



Two Murray Vertical Type V Turbines driving Deep Well Pumps in a southern Oil Refinery. They are rated at 113 H.P. at 1750 RPM and operate with 600#—650° F. steam extracting to atmosphere.

• Murray Vertical V turbines, both geared and direct-connected, are being used more and more for driving vertical pumps of all types. The Murray Vertical V turbine is designed from top to bottom as a vertical turbine, not just a horizontal turbine, "upended." The Murray Vertical is especially constructed and arranged for vertical mounting.

Murray vertical turbines can be furnished for steam pressures up to 600#, 750° F. TT. and back pressures as high as 100# and can carry most normal thrust loads imposed by vertical pumps.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

As Management Sees It . . .

people. However, a carefully planned course, such as the one described, will separate the "apples from the oranges."

Automation—This is the final topic of the series and some of the thoughts derived from this subject include:

- There is need for automation to make more products better and/or cheaper. It is apparent that competition sees to that situation under normal conditions.
- Since labor dislocation will ensue, management should work out a solution to cause the least economic harm to those affected and educate a new group to handle the new equipment. This could mean that new employes would need higher educational training. Although automation may mean the loss of jobs by certain employes, there will be more need for salesmen, retailers and distributors since there will be more people needed to supply the goods as demand increases.
- The market should be considered as embracing the free world as new wealth is created. It is doubted somewhat if the labor supply in the future can meet the demand, so that automatic machinery and controls will have to be used to satisfy product demand.
- The three groups were optimistic about the "pushbutton" era and were insistent that our leaders show vision in their future planning. They want to see the standard of living raised throughout the world, new wealth created, more people gainfully employed and a chance to regain the adventurous spirit of our forefathers.

Finally, the subjects discussed are timely, the method of training is unique as well as sound. Above all, those who participated were genuinely enthusiastic with the program.

Such programs should receive enthusiastic approval by the stockholders of any company. A board of directors should give ready acceptance and it is predicted that when one member from this group becomes a board member, he will be better prepared than many others—better prepared because he has had this earnest, intimate study of management's problems on a local level early in his career. # #

GENERAL REFRACTORIES

time . . . measured by BRICK

The pulsing spring of the conductor's watch . . . the soaring radio tower of the Naval Observatory . . . the clock on your nightstand regulated by the 60-cycle current of your electricity . . . all owe their existence to brick.

It's refractory brick controlling the flames of industry, producing metals, glass, electricity that combine to measure and communicate time.

Refractories are the industry behind industry—*all* industry, for everything that's made or moved requires them. To provide them in the infinite variety that industry demands, General Refractories employs advanced scientific research, draws on the world for materials, and produces in plants strategically located to serve industry with a complete refractories service.

The Industry Behind Industry
GENERAL REFRACTORIES COMPANY
Philadelphia 2

SEND FOR THE MOTION PICTURE: THE GREFCO STORY

It is a beautiful 16 mm. motion picture in full color which relates the fascinating and little understood story about the refractories industry . . . *the industry behind industry*. Viewing time is 26 minutes. If you would like to show it to executive, employee, social, church or other groups, a request on your letter head is all that is necessary. Address General Refractories, Philadelphia 2.

Showmanship Can Prevent Accidents

Here are five safety stimulators especially designed to inject new vigor into your accident-prevention program.

IT TAKES showmanship—and plenty of it—to spark employe interest in accident prevention. New ideas must constantly be injected into your refinery safety program to keep employes from developing a feeling of false security. There are countless ways to keep your program dynamic and challenging. Here is a roundup of some ideas which have worked successfully in various refineries to revive employe interest in accident prevention.

SAFETY DRAWING

This safety stimulator takes the chance out of the work around the refinery and puts it into a weekly safety drawing.

All safety-minded employes are eligible to participate in the project. One or more names or badge numbers are drawn each week. The lucky employes each receive a cash award—5, 10 or 25 dollars.

Eligibility is based on accident-free work. Employes involved in an accident are not eligible to have their name drawn for two weeks after the date of the accident.

One refinery makes the entire department ineligible for a week even though only one of its employes is responsible for an accident. This builds a spirit of safety cooperation throughout the refinery.

SHOWMANSHIP

One refinery safety director successfully developed a safety show whereby the right and wrong way to do various refinery jobs were dramatized by employes. One of the "actors" illustrated the "show off." He did things that no member of the audience would ever think of doing. The "strong man" was aped by a refinery worker who showed off his great lifting power (the wrong way). He was immediately shown up by his ten-year-old son who lifted in the correct manner.

Another idea is to construct a mechanical man that shows the strain on the back caused by improper lifting. This can be used to tell the old safety story in a new, memorable way.

You can also translate accident statistics into an illustration that is easy to visualize . . . the cost of lost time can be illustrated by showing the amount of fishing equipment it would buy.

Introducing...

The New BS&B Type 1460 Temperature Controller

Vapor-Tension Sensing System	
Bulb Range	Recommended Working Range
0-100° F.	20-90° F.
40-140° F.	60-130° F.
40-240° F.	90-220° F.
100-350° F.	175-335° F.

Gives Positive Fluid-Flow Control Through Diaphragm Operated Valves, Based On Temperature Variations

The new BS&B Type 1460 Temperature Controller or Pilot is equipped with an external vapor-tension thermal system to actuate the power unit in the pilot.

Except for this actuating mechanism and the temperature indicator which is an integral part of it, the 1460 Controller has all of the excellent features offered in the well-known BS&B Type 1440 Control Pilot—including the ¼" supply medium reducing regulator and two pressure gauges.

This unit is especially suited for translating temperature variations to direct flow-control of fuel, or of heating or cooling medium, through diaphragm operated valves.

FEATURES

- Vapor-Tension Sensing System
- Choice of Temperature Ranges
- Built-In Temperature Indicator
- Simple Adjustment Permits Either 100% Throttling Action—Or "On-Off" Snap Action Within A Wide Limiting Range.
- Parts Interchangeability With BS&B 1440 And 1450 Pilots Reduces Maintenance Cost And Parts Inventory.

Ask your BS&B Representative for more details—or write to . . .

BS&B

ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

Controls Division, Dept. 4-F2

7500 East 12th Street — Kansas City 26, Missouri

For more data on advertised products, use Readers' Service Cards, last page.

TO REPAIR PIPE LEAKS—
QUICKLY, PERMANENTLY
ANY PRESSURE — ANY TEMPERATURE

SKINNER-SEAL EMERGENCY PIPE CLAMP
for pinhole or corrosion leaks.

SKINNER-SEAL PIPE LINE CLAMP for
long splits and bad corrosion leaks.

In stock—all supply stores

M. B. SKINNER COMPANY
SOUTH BEND 21, INDIANA, U. S. A.

NEW
STAINLESS
STEEL PIPE

Approx. 804 ft. (29,587#) 14" OD–Sch. 10
$25.76 per foot

Approx. 2930 ft. (185,469#) 14" OD–Sch. 40
$37.98 per foot

Type 304, Welded, Plain Ends,
Extra Low Carbon
10 foot Lengths

Sch. 10–36.8# per foot–.250" wall
Accordance Mill Tolerances

Sch. 40–63.3# per foot–.437" wall
Accordance Mill Tolerances

Heat numbers on request

IMMEDIATE SHIPMENT

WRITE • PHONE • WIRE
William Fabrikant
WF STEEL PRODUCTS, INC.
Park Sheraton Hotel — Suite 2364
202 WEST 56th STREET
NEW YORK 19, N. Y.
Plaza 7-5622

SAFETY CLOTHING

Several refineries have found that sales promotion of safety clothing is effective. For example, a representative from a clothing manufacturer may be invited to set up a display in the plant. Employes are allowed to shop on company time and get credit for safety clothing purchases through payroll deductions.

In one instance, the refinery safety director prepared a list of approved safety clothing and distributed it to all employes. A handy check list order form was prepared and employe orders were pooled for fast delivery and for more reasonable prices.

Even though employe response may not be overwhelming, a subtle safety reminder has been planted that will remain long after the printed lists are distributed.

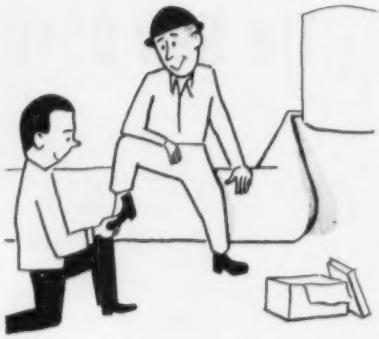
PERSONALIZED POSTERS

Safety posters are good safety stimulators. Their value can be increased, however, if they are personalized to the refinery and the employes. Photos of accidents add a personal touch and tend to stimulate the thought, "It could happen here, or to me."

One refinery ran a series of photos of accident causes. These were not identified by location, and the poster asked, "Where Is This?"

Employes made guesses about the location of the unsafe conditions. They checked the source of the hazard with workers in other departments, and thus were more careful in their own work space. The employes were made safety conscious through this curiosity-provoking idea and the accident rate took a downward dip. ##

As Management Sees It . . .



SAFETY SLOGANS

Prizes stimulate interest in any program. Safety is no exception. In one refinery, the safety director worked out a monthly safety slogan contest. Every one in the company was eligible to enter any number of slogans.

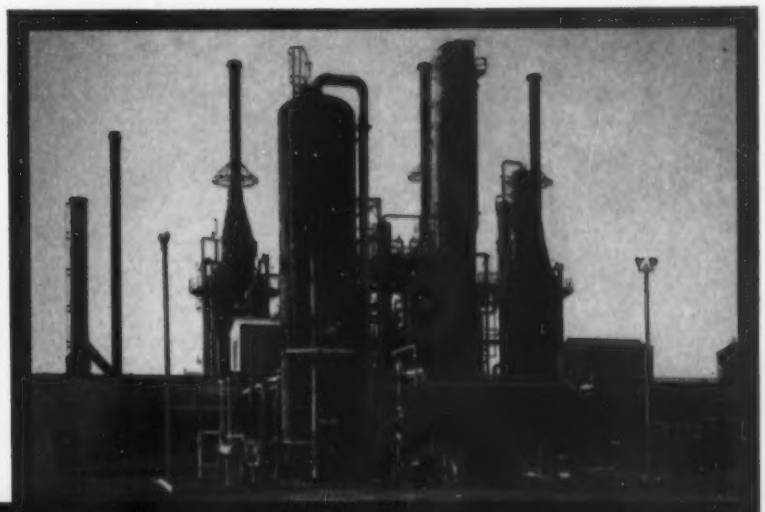
Winners usually twisted a popular saying into a safety slogan. For instances, the jive talk expression, "Don't be a square," was used in a prize-winning safety slogan, "Don't be a square—stick around."

Even if the slogans submitted are not as good as the professionally prepared safety messages, the effect is usually better. The winning slogan will catch on. Everyone will be using it because it was created by a fellow worker.

For more data on advertised products, use Readers' Service Cards, last page.

TO INSURE

smooth operations
more time on stream
lower operating costs
better products



TRETOLITE REFINERY SERVICES

DESALTING

CORROSION PREVENTIVES

FUEL EMULSION PREVENTIVE

METAL DEACTIVATOR

Desalting the crude charge before refining is now accepted as standard operating procedure. Desalting removes salts which evolve into corrosive acids. It prevents salt plugging of condensers, exchangers and towers, and keeps solids and fines from entering the refinery. Tretolite desalting is an automatic, all chemical process, consistently delivering salt removals in the 98 to 100% range.

Kontol Corrosion Preventives combat internal corrosion, hydrogen blistering, fouling and scaling. They are organic semi-polar liquids which protect by adsorbing at metal surfaces as a tough, impervious film. They are readily adsorbed from dilute hydrocarbon solutions to form this film. In addition to their corrosion preventive properties, the Kontols are powerful detergents which clean and de-foul refining equipment.

Tretolite Fuel Emulsion Preventive is an organic, oil-soluble agent designed to prevent the emulsification and sludging of burning oils and diesel fuels. Oils treated with Tretolite Fuel Emulsion Preventive have shown no sludge formation even after a three month settling test.

Kuplex Metal Deactivator effectively deactivates copper in hydrocarbons such as gasoline, kerosine, jet fuel, diesel oil, furnace oil and turbine oil. Its powerful chelating action prevents hydrocarbon deterioration caused by metal catalyzed oxidation.

For complete information, technical data and prices, ask your Tretolite refinery service engineer or write to –

TRETOLITE COMPANY
A DIVISION OF PETROLITE CORPORATION
369 Marshall Avenue, Saint Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

TD 56-12

Chemicals and Services for the Petroleum Industry

DESALTING • DEMULSIFYING • CORROSION PREVENTING
SCALE INHIBITING • FUEL OIL ADDITIVES • WATER
DE-OILING • PARAFFIN REMOVING • PRODUCTION
STIMULATING • BACTERICIDES • METAL CONDITIONERS

For more data on advertised products, use Readers' Service Cards, last page.

Brown Fintube

The above photo shows a large Houston Petro-Chemical (Synthetic Ammonia) Plant with 9 compressor stations . . . a total of 54 coolers or 306 high pressure heat exchanger sections. Pressures from 72 psi to 5300 psi.

Brown high pressure heat exchanger sections are now performing, with high efficiency, in almost all the Petro-Chemical plants that have been built in the last five years.

BFT high pressure sectional heat exchangers are available for pressures up to 22,000 psi.

High Pressure

HEAT EXCHANGER SECTIONS

HEAT EXCHANGE SURFACE

BROWN FINTUBE

HEAT TRANSFER PRODUCTS

BROWN FINTUBE COMPANY

Elyria, Ohio

What's Happening . . .

. . . in the Industry

Average Octane Rating Hits 95.5 for Premium

Average octane ratings for premium-grade gasoline in the U. S. now stands at 95.5, according to Du Pont Company's latest quarterly survey. The national average for regular-grade gasoline runs 88.1.

The survey shows premium octane ratings up in 35 cities since the survey taken in October. Six cities, Little Rock, Corpus Christi, Memphis, Jacksonville, Shreveport and Houston, had gasoline with an average number of at least 97. Some 14 cities has average octane numbers between 96 and 97.

In New York, Philadelphia, Pittsburgh, Boston and Baltimore, regular numbers ran 91 or better. Five cities had average octane ratings running between 90 and 91.

Division of Refining Schedules Program for Canadian Meeting

Members of the petroleum-refining industry will gather in Montreal this year for the twenty-first midyear meeting of the American Petroleum Institute's Division of Refining.

The meeting, to be held May 11-17, will mark the first time the division has met outside the U. S. The Canadian city was selected to "signal recognition of the dominion's growing oil industry."

The four-day meeting will be held at the Sheraton-Mount Royal Hotel. The program calls for 12 technical group sessions and an open dinner.

Subjects to be covered at the sessions are analytical research, corrosion, electrical equipment, trends in refinery instrumentation, computers, refinery maintenance, fuels and lubricants, processes, smoke and fumes, waste disposal and training.

Preliminary program for the meeting follows:

MONDAY, MAY 14, 1956

9:00 a.m. Analytical Research

Presiding: G. R. Lake, Union Oil Company of California, Brea, Calif. Session developed by G. R. Lake, Union Oil Company of California, Brea, Calif. Spectrophotometric Determination of Chloride, Bromide and Iodide. F. W. Chapman, Jr., and R. M. Sherwood, The Atlantic Refining Company, Philadelphia, Pa. Trace Amounts of Arsenic in Petroleum Distillates. N. C. Maranowski, R. E. Snyder, and R. O. Clark, Gulf Research and Development Company, Pittsburgh, Pa. Trace Amounts of Total Nitrogen in Petroleum Distillates. G. R. Bond, Jr., and C. G. Harriz, Houdry Process Corporation, Marcus Hook, Pa. X-ray Absorption Edge Spectroscopy as an Analytical Tool. The Determination of Molybdenum and Zinc. R. E. Barieau, California Research Corporation, Richmond, Calif. Trace Quantities of Lead in Gasolines and Naphthas. Margaret E. Griffing, L. A. Snyder, S. R. Henderson, and Adele Rozek, Ethyl Corporation, Detroit, Mich. Determination of Water in Methane and Ethanethiol. G. Matsuyama, Union Oil Company of California, Brea, Calif. Traces of Carbon Monoxide in Hydrocarbons. K. H. Nelson, M. D. Grimes, and B. J. Heinrich, Phillips Petroleum Company, Bartlesville, Okla.

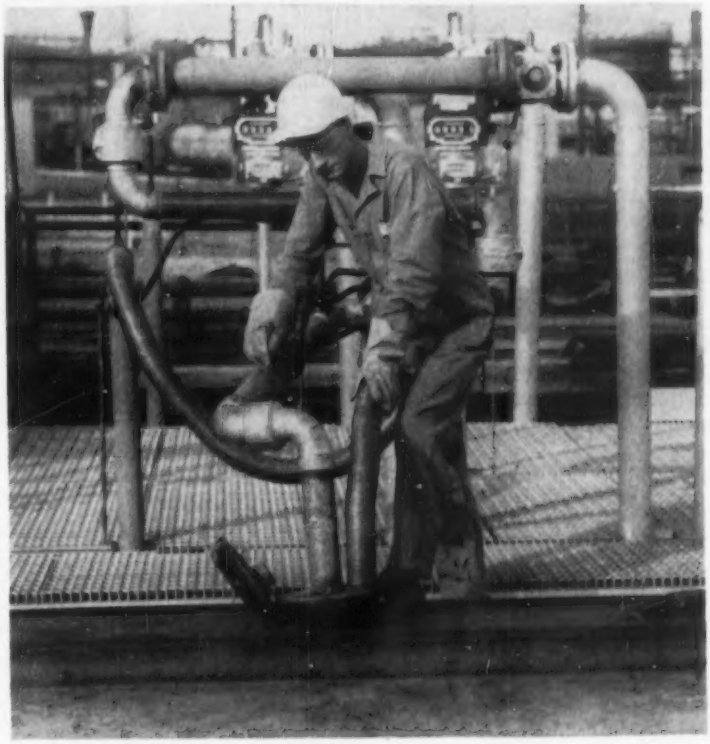
9:00 a.m. Corrosion

Presiding: G. L. MacPherson, Imperial Oil, Ltd., Toronto, Canada. Session developed by C. F. Pogacar, The Atlantic Refining Company, Philadelphia, Pa. Current Good Painting Practices. Joseph Bigos, Steel Structures Painting Council, Mellon Institute of Industrial Research, Pittsburgh, Pa.; and J. O. Jackson, Pittsburgh-Des Moines Steel Company, Pittsburgh, Pa. Corrosion Occurring in Crude and Vacuum Distillation Units. P. D. Thomas, Asiatic Petroleum Company, New York, N. Y. How Richfield Planned to Combat High-Temperature Sulfide Corrosion in Their New Catalytic Reformer. B. W. Neumaier, and C. M. Schillmoller, Richfield Oil Corporation, Wilmington, Calif. Hydrogen Sulfide Corrosion in Commercial Catalytic Reforming Units. R. D. Drew and E. B. Backensto, Socony Mobil Laboratories, Paulsboro, N. J.; J. N. Vlachos, Socony Mobil Oil Company, Inc., New York. Results from Stress Rupture Tests of Graphitized Carbon Steels—A Summary Report of the Work of the Subgroup on Deterioration of Steels, Subcommittee on Unfired Pressure Vessels, Committee on Refinery Equipment. J. G. Wilson, Shell Oil Company, New York, on behalf of the Subgroup.

2:00 p.m. Analytical Research

Presiding: G. W. Gurd, Imperial Oil, Ltd., Toronto. Application of Vapour Phase Chromatography to the Analysis of Liquid Petroleum Fractions. D. H. Desty and B. H. F. Whyman, British Petroleum Company, Ltd., London, England. Quantative Analysis of Organic Disulfides. Mrs. R. L. Hubbard, W. E. Haines, and J. S. Ball, U. S. Bureau of Mines, Bartlesville, Okla. Determination of Fuel Oil Stability by Optical Density Measurements. W. H. Armstrong, D. Milsom, H. P. Hebert, and A. R. Rescorla, Cities Service Research and Development Company, Hillside, N. J. A Rapid, Precise Micro Vapor Pressure Method. A. Y. Mattlau, Esso Research and Engineering Company, Linden, N. J. Combustion—Titrimetric Determination of Total Sulfur in Liquid Petroleum Products. O. N. Hinsvark and F. J. O'Hara, The Girdler Corporation, Louisville, Ky. Fluorescent X-ray Spectral Analysis of Powdered Solids by Matrix Dilution. E. L. Gunn, Humble Oil & Refining Company, Baytown, Texas. Hydrogen in Petroleum Products by Beta Absorption. J. W. Wilczewski, J. S. Wiberly,

New Vapor-Recovery Unit

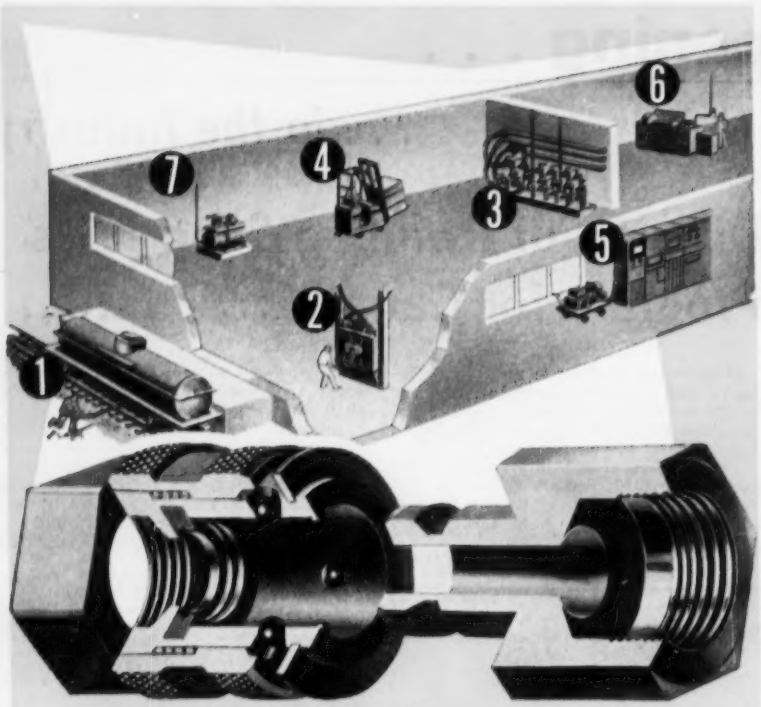


Five separate installations for the recovery of hydrocarbon vapors from truck loading of gasoline are in operation or under construction by Standard Oil Company of California.

One of these units is at the company's El Segundo refinery, and the others are located at bulk-loading stations. This equipment, which together cost $541,000, is expected to recover about 3½ tons a day of hydrocarbon vapors now being lost to the air.

In early 1954 member companies of the Western Oil and Gas Association agreed to try to solve the problem of hydrocarbon losses from truck loading. Standard's contribution to this voluntary program was the design and construction of its new recovery equipment.

The recovery equipment at El Segundo, where other vapor-recovery systems, have been in operation for many years, will use vapor collecting equipment of recent design. Vapors will be recovered by augmented existing recovery equipment.



whatever the operation . . .

Titeflex Quick-Seal Couplings for fast, leakproof connections!

Everywhere in industrial operations, you find Titeflex Quick-Seal Couplings "making connections"! And what connections! *Absolutely* leakproof. Couple or uncouple in *one second*. Allow free flow of *any* material. Sizes ¼" to 12".

See drawing for typical uses. Then check your own plant for trouble spots where Quick-Seal Couplings can serve you *profitably*. For details . . . send coupon.

1. Tank Car Unloading
2. Furnace Doors
3. Blending "Switchboards"
4. Lift Trucks—Hydraulic Lines
5. Mobile Testing Equipment
6. Machine Cleaning
7. Air Lines for Tools

Titeflex

TITEFLEX, INC. (Industrial Products Div.)
601 Hendee Street, Springfield, Mass.
Send me your free Quick-Seal Couplings Catalog—don't obligate me.

Name_____ Title_____

Firm_____

Address_____

City_____ Zone_____ State_____

Titeflex Quick-Seal Couplings • *Leakproof at all operating pressures, in every application*

What's Happening. . .

and E. B. Childs, Socony Mobil Laboratories, Brooklyn, N. Y.

2:00 p.m. Electrical Equipment

Session developed by K. N. Thompson, Socony Mobile Oil Company, Inc., New York, N. Y. A Refiner's Experiences in Using RP-500. F. C. Somers, The Atlantic Refining Company, Philadelphia, Pa. An engineering Contractor's Reaction to RP-500. James T. Pr.ngle, Bechtel Corporation, San Francisco, Calif. Problems in Providing Suitable Electrical Equipment for Class I, Division 2 Areas. C. A. Olson, Westinghouse Electric Corporation, Pittsburgh, Pa.; and Earle R. Hoyle, Sinclair Refining Company, East Chicago, Ind. Differences Between Canadian and American Refinery Electrical Practices. Imperial Oil Company, Ltd.

TUESDAY, MAY 15, 1956

9:00 a.m. Trends in Refinery Instrumentation

Presiding: J. K. Jamieson, Imperial Oil, Ltd., Toronto. Session developed by G. N. Ehly, The Atlantic Refining Company, Philadelphia, Pa. Service of the Instrument Society of America to the Petroleum Industry. Robert T. Sheen, Milton Roy Company, Philadelphia, Pa. Instrumentation of Petroleum Processes. James G. Kerley, Shell Oil Company, New York. Data Reduction (or Automatic Logging, or Automatic Intelligence Gathering Systems). Albert F. Sperry, Panellit, Inc., Skokie, Ill.

9:00 a.m. Computers

Session developed by C. L. Thomas, Sun Oil Company, Marcus Hook, Pa. The Use of Computers in Petroleum Refinery Problems. Jack Sherman, The Texas Company, Houston. The Design of Heat Exchangers on Automatic Computing Equipment. A. M. Peiser, The M. W. Kellogg Company, Jersey City, N. J. Computers in Refinery Planning. Robert G. Donovan and Robert W. Schrage, Esso Standard Oil Company, Linden, N. J. Calculation of the Equilibrium Composition in C_4 Hydrocarbon-Hydrogen Systems. Edward B. Weinberger and C. W. Montgomery, Gulf Research and Development Company, Pittsburgh, Pa. Paper: Shell Oil Company, New York, N. Y.

2:00 p.m. Refinery Maintenance

Presiding: Gordon R. Henderson, Sun Oil Company, Ltd., Sarnia, Canada. Session developed by D. R. Johnson, Continental Oil Company, Houston. Scope and Administration of Preventive Maintenance. C. C. Carmine, Tide Water Associated Oil Company, Associated, Calif. Development of Cost Yardsticks. E. S. Bale, The Standard Oil Company (Ohio), Cleveland, Ohio. Prepared Discussion—E. C. Newton, The Atlantic Refining Company, Philadelphia, Pa. Corrosion—The Maintenance Engineer's No. 1 Enemy. F. C. Braun, Gulf Oil Corporation, Pittsburgh, Pa.

2:00 p.m. Fuels and Lubricants

Presiding: G. Davidson, Shell Oil Co. of Canada, Ltd., Toronto. Session developed by T. B. Rendel, Shell Oil Company, New York. Statistical Approach to Road Performance. F. D. Buerstetta, Ethyl Corporation, Detroit, Mich., and E. E. Sorenson, The British American Oil Company, Ltd., Toronto. The Combustion Chamber Deposit Problem in High Compression Ratio Engines. M. W. Corzilius, D. R. Diggs, and R. A. Hoffman, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del. Handling High Vapor Pressure Fuels. A. E. Cleveland, Ford Motor Company, Dearborn, Mich.

7:00 p.m. Processes

Session developed by C. L. Thomas, Sun Oil Company, Marcus Hook, Pa. Theme: 95 plus Octane Numbers. A five paper session is planned.

WEDNESDAY, MAY 16, 1956

9:00 a.m. Smoke and Fumes

Presiding: John W. Newton, Magnolia Petroleum Company, Beaumont, Texas. Session developed by W. H. Claussen, California Research Corporation, San Francisco. Review of the Smoke and Fumes Committee Research Program. L. C. Kemp, Jr., The Texas Company, New York. Recent Developments in the Study of the Organic Chemistry of the Atmosphere. W. E. Scott, E. R. Stephens, and Philip L. Hanst, The Franklin Institute, Philadelphia, Pa. Panel Discussion: Air Pollution Control Policy. Moderator: John W. Newton. Panel Members: E. B. McConnell, The Standard Oil Company (Ohio), Cleveland, Ohio. H. G. Osborn, Continental Oil Company, Ponca City, Okla. H. W. Ferguson, Humble Oil & Refining Company, Houston, Texas G. S. Dunham, Socony Mobil Oil Company, Incorporated, New York.

2:00 p.m. Waste Disposal

Presiding: John R. Patton, The British American Oil Company, Ltd., Port Credit, Ontario, Canada. Session developed by W. F. Meehan, Standard Oil Company (Indiana), Whiting, Ind.

An Evaluation of the Accomplishments of the Committee on Disposal of Refinery Wastes. W. B. Hart, The Atlantic Refining Company, Philadelphia, Pa. Sulfide Removal from Process Water by Air Oxidation. A. G. Smith, Shell Oil Company, Wilmington, Calif. Biological Oxidation of Phenolic Waste Water. Alex D. McRae, Imperial Oil, Ltd., Sarnia, Ontario. The Diatometer—A Method for Indicating the Conditions of Aquatic Life. Ruth Patrick Hodge, Academy of Natural Sciences, Philadelphia, Pa. A fifth paper will

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening. . .

be presented by—W. Herman Barcus, Sun Oil Co., Marcus Hook, Pa.

7:00 p.m. Open Dinner Session

Presiding: E. B. McConnell, vice president for refining (American Petroleum Institute); The Standard Oil Co. (Ohio), Cleveland, Ohio. Session developed by D. L. Campbell, The British American Oil Co., Ltd., Toronto. Opening Remarks: E. B. McConnell, vice president for refining. Presentation of the API "Certificate of Appreciation." Address: Frank M. Porter, president, American Petroleum Institute, New York, N. Y. Tentative Address: Louis St. Laurent, Prime Minister of Canada.

THURSDAY, MAY 17, 1956

9:00 a.m. Training

Presiding: W. Harold Rea, Canadian Oil Companies, Ltd., Toronto. Session developed by R. R. Faller, Ethyl Corporation, New York. Developing Engineers in the Field of Refinery Technology. Dwight S. Simmons, Imperial Oil, Ltd., Toronto. The Liberal Arts in Executive Development. J. Roby Kidd, Canadian Association for Adult Education, Toronto. The Line Manager's Role in Supervisory Development. G. Davidson, Shell Oil Company of Canada, Ltd., Toronto.

Sun Oil Promotes Training in Science

Sun Oil Company was one of three industrial concerns to receive a Poor Richard Almanack Award in ceremonies held at Philadelphia's Franklin Institute, marking the 250th anniversary of the birth of Benjamin Franklin. The other corporations honored were General Electric and Leeds and Northrup Company.

Theme of the celebration was to encourage students to take up scientific and engineering careers. To promote this effort, Sun is distributing 250,000 reprints of an article entitled, "Should Your Child Choose a Career in Science?"

The article, contributed by J. Bennett Hill, Sun's director of research, appeared in the Spring 1955 issue of the company magazine *Our Sun*. Reprints are being sent to 53 science museums throughout the U. S.

Moves Headquarters

Commonwealth Oil Refining Company, formerly headquartered in New York, has relocated in Boston. The company's executive offices now are at 10 Post Office Square, Boston.

Senate May Investigate Synthetic-Rubber Sales

Senate Banking Committee is considering an investigation of the disposal of government synthetic-rubber plants. Presumably, the committee would look into the antitrust aspects of the sales and con-

Copies of Index Still Available

Copies of the 1955 PETROLEUM REFINER Index, which in the past always has appeared in the December issue, are still available to subscribers—now upon request. Readers who want this valuable guide to the past year's advancements in refining, petrochemicals and natural gasoline should use the Reader's Service green card in the back of this issue. Write on the card, "1955 PETROLEUM REFINER Index," fill in name, address and mail. There is no charge or obligation.

versatile, durable
Titeflex metal hose . . .
for every type of processing operation

Can take grueling punishment from corrosive fluids, high temperatures, excessive vibration and pressures . . . or from any combination of these industrial *spoilers*. All-metal construction. Wide range of sizes. Braided or unbraided. Choice of alloys and fittings to meet *every* need.

Titeflex Metal Hose finds many important jobs *everywhere*. Investigate your processing operations now and see where Titeflex Flexible Metal Hose can work for you. Send in coupon for important additional information *today*.

1. Fire Extinguisher
2. Air Control Lines
3. Cleaning Vats
4. Air Conditioning Units
5. Milling Machine
6. Hydraulic Press—Lubricating Lines
7. Steam Lines

Titeflex

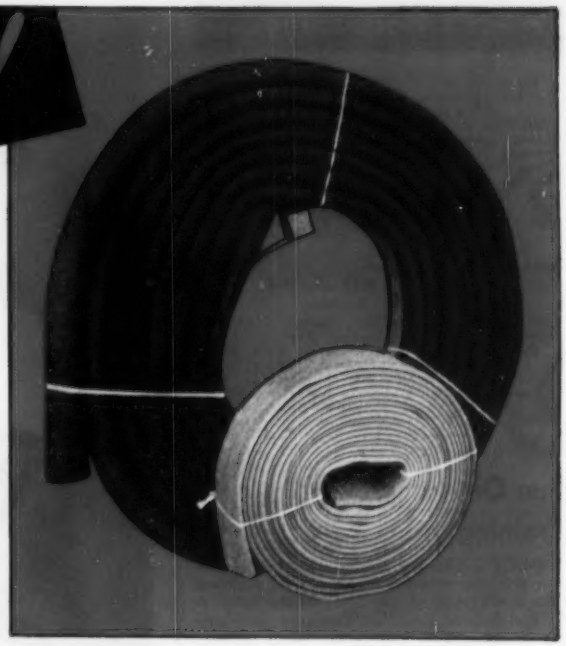
TITEFLEX, INC. (Industrial Products Div.)
600 Hendee Street, Springfield, Mass.
Send me your free Titeflex Flexible Hose Catalog without obligating me.

Name _____ Title _____
Firm _____
Address _____
City _____ Zone _____ State _____

TITEFLEX FLEXIBLE METAL HOSE licks corrosion temperature vibration pressure *in all industrial operations*

For more data on advertised products, use Readers' Service Cards, last page.

Unbelievable!



Until You See it... Feel it... Test it!

GOODALL "Lite-Flex" FIRE HOSE

GREATEST ADVANCE IN FIRE HOSE CONSTRUCTION IN OVER HALF A CENTURY! AMAZINGLY LIGHT, STRONG, FLEXIBLE!

Here's the new hose that completely changes all previous conceptions of weight, strength, flexibility and bulk in fire hose for Oil Refineries, Chemical Plants and other installations where oils, chemicals, greases and other deteriorating agents are present. Less than *half* the weight of regular neoprene covered hose, it has a much *higher* burst pressure rating, and its *flexibility* far surpasses any other conventional fire hose. The vast difference in *bulk* between "Lite-Flex" and regular neoprene covered hose is illustrated above—a 100' coil of "Lite-Flex" compared to a 50' coil of standard neoprene covered.

The very thin, lightweight jacket combines high-tensile fibres by a special weaving process that provides exceptional strength, with highest resistance to pressure, wear and rough handling. A cover of gray latex assures long-lasting protection from chemicals, oils, greases and moisture penetration.

"Lite-Flex" is fully rubber lined . . . seamless, multiple-ply laminated, reinforced construction, with a smooth waterway to insure unrestricted flow. Sizes 1½" and 2½", in maximum lengths of 100 feet.

★ ★ ★

Where *exceptionally high* abrasion and/or chemical resistance is a factor, ask about "Syn-Flex"—a new hose similar in construction to "Lite-Flex", but with a black "Synplastic"® cover.

GOODALL RUBBER COMPANY Date_____
448 Whitehead Rd., Trenton 4, N. J.
☐ Send Complete Information on ☐ "LITE-FLEX" ☐ "SYN-FLEX"
☐ Send Representative With Samples
Company_____
Address_____
City_____ Zone_____ State_____

Standard of Quality—Since 1870 HOSE · BELTING · FOOTWEAR · CLOTHING AND OTHER INDUSTRIAL RUBBER PRODUCTS

GOODALL *Rubber Company*

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.
Branches and Distributors Throughout the United States and in Canada

"If it's GOODALL *... it* MUST *be Good!"*

sider the prices received for plants. The latest synthetic-rubber facilities to pass into the hands of private industry was the plant at Institute, W. Va., purchased by Goodrich-Gulf Chemicals, Inc.

Government Due to Sell Last Rubber Plant

Congress is expected to authorize sale of the alcohol-butadiene plant at Louisville, Ky.—the last of the government's synthetic-rubber-producing facilities. A bill will be introduced in both houses, calling for:

- A 30-day period for the Rubber Producing Facilities Disposal Commission to receive bids from buyers interested in the Louisville plant.
- An additional 45 days for the negotiation of its sale.
- Another 10 days for the commission to submit a report on the proposed sale to Congress.
- And 30 days for Congress to approve the measure.

If the plant has not been sold at the end of the 115 days outlined, the disposal agency will go out of existence. In such case, the sale would be handled by some other appropriate agency, possibly the General Services Administration.

Natural-Gas Liquid Output Climbs

Average production of natural-gas liquids in November 1955 ran 33,100,000 gallons a day. This is a figure released by the Bureau of Mines. It represents a 9-percent increase of the same period in 1954.

Daily average output of liquified gases at refineries was 5,100,000 gallons, 26 percent more than in November 1954.

Liquified-gas stocks at the end of November equalled 462,000,000 gallons, or 65,000,000 gallons less than at the first of the month. Underground storage totaled 336 million gallons.

Buys Gasoline Plant

Rycade Oil Corporation, purchasing the West Texas oil properties of C. V. Lyman, has acquired a 12-Mmcf.-a-day natural-gasoline plant in Winkler County, Texas.

Refining Dividends Up

Petroleum-refining companies paid out $827,200,000 in dividends during the 11 months ended November 1955, according

Heat-Exchanger Design

Daniel Donohue, author of "Heat Exchanger Design," a four-part series which was concluded in PETROLEUM REFINER last month, is handling reprints of his article. These may be obtained direct from him at a cost of $1 a copy. The address listed last month was incorrect. Orders should be sent to

Daniel Donohue, Corporation
109 Seaman Avenue
New York 34, N. Y.

users say

Chemiseals pay

in longer trouble-free life---

Customers report unsurpassed performance in the following applications.

CONCENTRATED H_2SO_4 ACID	Aurora Pump. 1750 r.p.m. 1⅛ inch shaft. 2 lbs. suction. 45 lbs. discharge. Temperature of medium 65°C. Not flushed.
UREA-WATER SOLUTION	Ingersoll-Rand Pump. 1750 rpm. 1⅛ inch shaft. 2 lbs. suction. 35 lbs. discharge. Temperature of medium 100°C. Not flushed.
HYDROCARBON FEED	Labour Pump. 1750 rpm. 1⅛ inch shaft. 10 lbs. suction, 25 lbs. discharge. Temperature of medium 102°C. Not flushed.
ADIPIC ACID and HYDROCARBON SLURRY	Labour Pump. 1750 rpm. 1⅛ inch shaft. 35 lbs. suction, 75 lbs. discharge. Temperature of medium 70°C. Seal flushed.
UREA-NH_3 SOLUTION	Ingersoll-Rand Pump. 3600 rpm. 1⅛ inch shaft. 10 lbs. suction, 50 lbs. discharge. Temperature of medium 75°C. Not flushed.
ESTER (10% Solids)	Byron Jackson Pump. 3600 rpm. 625 lbs. discharge. 30 lbs. suction. Stuffing box pressure 15 lbs. to 65 lbs. Temperature of medium 70°C. Seal flushed.
HYDROXYACETIC and SULFURIC ACID	Allis-Chalmers Pump. 1750 rpm. 1½ inch shaft. 10 lbs. suction, 60 lbs. discharge. Temperature of medium 30°C. Not flushed.

What are your shaft sealing problems? Write for Bulletin MS-1155.

UGS BELMONT

UNITED STATES GASKET CO.
Camden 1, New Jersey

U.S. GASKET • BELMONT PACKING

For more data on advertised products, use Readers' Service Cards, last page

... Don't overlook this speedier

Power Drive

that takes the work out of pipe threading, cutting, reaming...

RIDGID

400A with wrenchless *SPEED CHUCK*

Lots of ready power turns pipe, conduit or rod for your hand threaders, cutters, reamers—even up to 12" geared tools with drive shaft. New Speed Chuck opens and closes easily, guaranteed to grip tight forward, reverse; jaws have replaceable insert teeth for longer life. Light, compact, portable—built for years of service. Bench, stand and wheelstand models. See and try the 400A—at your Supply House!

RIDGID 504
quick-opening threader for power drive use—self-contained dies for 1" to 2" pipe or conduit.

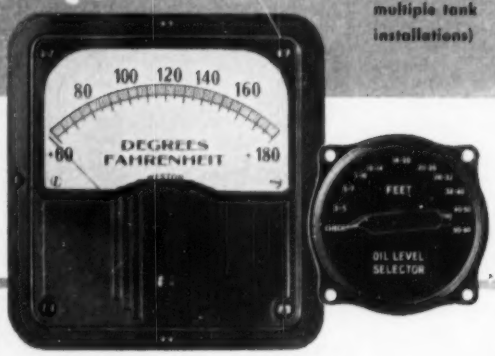
"Threaded Pipe—*It's Tight—It's Best—Costs Less*"

RIDGID
Work-Saver Pipe Tools

The Ridge Tool Company • Elyria, Ohio, U.S.A.

AVERAGE TANK TEMPERATURES INSTANTLY

(single or multiple tank installations)



WESTON

AVERAGING

RESISTANCE THERMOMETERS

Time saving...Money saving! You simply turn the selector switch to the oil depth, press the button, and directly read the *average* temperature of the oil in the tank. Time: *about one second flat!* Instruments can be mounted at base of tank, or at remote control points. For multiple tank installations special tank selector panels are supplied. For the complete story, write for bulletin... Weston Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J.—*a Subsidiary of Daystrom, Incorporated.*

Send for your copy today!

WESTON *Instruments*

to a report by the Department of Commerce's Office of Business Economics. This is compared with $765,900,000 for the same period of 1954.

In November, refiners paid out $6.9 million in dividends, as compared with $6.8 million for that month a year earlier.

Synthetic-Rubber Output Scores Record Year

The year 1955 was one of record production and sales for the rubber industry. The purchase and expansion by private industry of the synthetic-rubber-producing plants formerly owned by the government was one of the year's significant developments.

By increasing the output of synthetic rubber, the industry was able to provide its products at lower prices than would have been possible had it been forced to rely upon natural rubber alone. During the year, natural-rubber prices fluctated from a low of 29 cents a pound to 49 cents, while the price of synthetic rubber held constant at 23 cents.

Marketer Acquires Oklahoma Refinery

Gaseteria, Inc., an Indiana and Kentucky marketing concern, has purchased Johnson Oil Refining Company, operator of a 7000-barrel-a-day refinery at Cleveland, Okla. In addition to the refinery, Gaseteria acquires Johnson Oil's marketing facilities in five states.

The Cleveland refinery, which has been processing 6500 barrels a day, is equipped with a 3400-barrel-a-day thermal-cracking unit, an 1800-barrel-a-day catalytic-reforming plant, hydrogenation facilities and a catalytic-polymerization unit with a daily capacity of 200 barrels.

Petrochemical Construction Runs $46,786,000 in 1955

Cost of building new units for processing chemicals from petroleum and natural gas amounted to $46,786,000 in 1955. A report from the Manufacturing Chemists Association shows that $25,576 of that amount was spent on projects completed during the year; $8,086,000 went for projects still under construction at year's end, and $12,875,000 was committed for construction to be completed during 1956.

The heaviest investment in petrochemical construction during 1955 was in Louisiana. New projects in that state cost a total of $15,700,000. Texas, which ranked second, ran $14 million; Illinois was third with $5.4 million, and Ohio was fourth with $2 million.

Eleven Companies Certified Excellent

Eleven refining companies have been certified as excellently managed. Issued by the American Institute of Management, the certificates went to:

The Texas Company, Sun Oil Company, Standard Oil Company of California. The Standard Oil Company (Ohio), Standard Oil Company (New Jersey), Standard Oil

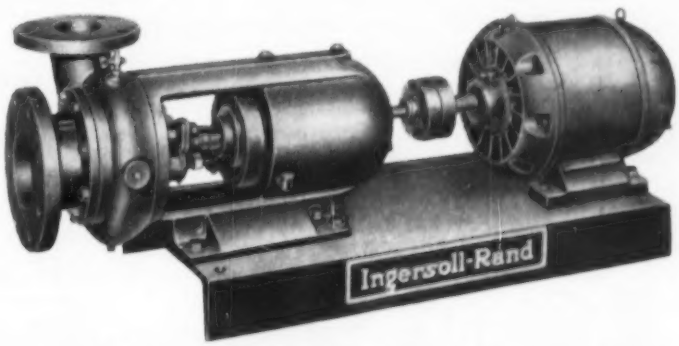
when you need flexibility in a pump...

I-R Cradle-Mounted Pumps

are star performers

Need a wide range of gallonages and heads? Want to keep parts inventory to a minimum? Want to put in just one cradle and have a wide choice of pump-ends and drives? Then Investigate I-R Cradle Mounted Pumps Today.

You'll find that practically every pump part, from oil rings to impellers, is interchangeable even in widely differing sizes — replacement inventories are minimized. Many pump-ends may be quickly and easily installed on a single cradle — differences in operating conditions and liquid requirements may be easily met.



What's more, you can pick the pumps you require from a range of capacities to 2800 gpm — heads to 525 ft. For complete data, write today to:

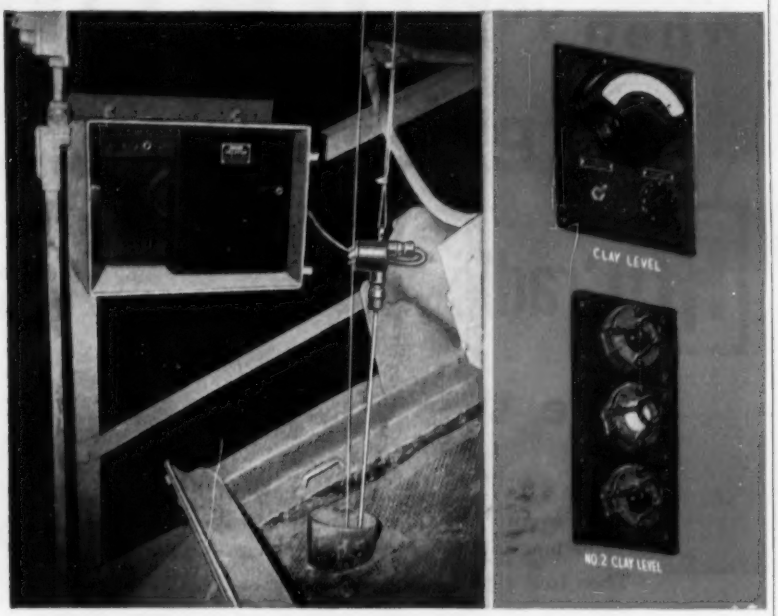
Ingersoll-Rand

9-219 11 Broadway, New York 4, N.Y.

Makers of Centrifugal Pumps for Every Industry!

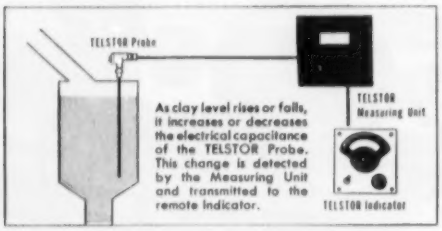
For more data on advertised products, use Readers' Service Cards, last page.

At Magnolia Petroleum TELSTOR Saves Operator Time and Clay



A Fielden TELSTOR System now enables operators at Magnolia Petroleum Co., Beaumont, Texas, to keep tabs on spent clay as it flows from a lube oil filter to a storage hopper to a revivifying kiln.

Because of its ability to measure all types of material and catalysts, TELSTOR shows clay level in the hopper with good accuracy. Its simple and completely safe electronic system is unaffected by the clogging nature of the oil-saturated clay. Send the coupon today for more facts about TELSTOR.


TELSTOR Probe
As clay level rises or falls, it increases or decreases the electrical capacitance of the TELSTOR Probe. This change is detected by the Measuring Unit and transmitted to the remote indicator.
TELSTOR Measuring Unit
TELSTOR Indicator

TELSTOR Features

- For liquids, liquid interface, powders, granular solids (conducting or non-conducting).
- Measures spans up to 200 feet or any portion.
- Maximum pressure 1000 psi (350° F.); maximum temperature 750° F. (150 psi).
- No moving parts—only one radio tube.

Robertshaw-Fulton CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION
Dept. H, 2920 N. 4th St., Philadelphia 33, Pa.

Please send me bulletins describing:
- ☐ TELSTOR Continuous Level Indicator
- ☐ TEKTOR Level Limit Control
- ☐ FIELDEN MULTI-POINT Recorders
- ☐ TEKTOLOG Recorders
- ☐ FIELDEN NULL-BALANCE Recorders

NAME_____ TITLE_____
COMPANY_____
STREET_____
CITY_____ ZONE____ STATE_____

What's Happening. . .

Company (Indiana), Socony Mobil Oil Company, Shamrock Oil and Gas Corporation, Shell Oil Company, Phillips Petroleum Company and The Ohio Oil Company.

Eight of these companies were receiving awards for their sixth consecutive year. They were Sun Oil, the Standards of California, Ohio, New Jersey and Indiana, Socony Mobil, Phillips and Ohio. Shell received the designation for its third consecutive year.

El Paso Natural Gas Forms New Subsidiary

El Paso Natural Gas Company has organized a new concern to operate the three refineries it recently acquired in New Mexico. The new affiliate will be El Paso Natural Gas Products Company. **(See Men in Industry.)**

It will operate the former McNutt Oil & Refining Company refinery at Brickland, N. M., and the two refineries purchased from Malco Refineries, Inc. The two Malco refineries are in New Mexico's San Juan Basin, one at Prewitt and the other at Bloomfield.

In addition, the products company will administer the parent company's half interest in the new butadiene plant scheduled for construction at Odessa, Texas. General Tire & Rubber Company is El Paso Natural's partner in the project.

Alkylation and blending facilities are other process equipment to be operated by the new affiliates. **(See Who's Building.)**

Gasoline Plant Sets Company Safety Record

Kerr-McGee Oil Industries, Inc., has a natural-gasoline plant, near Etter, Texas, which has not had a lost-time accident since it was put on stream in 1953. The plant has operated more than 1000 days with a safety record that is unprecedented in the company.

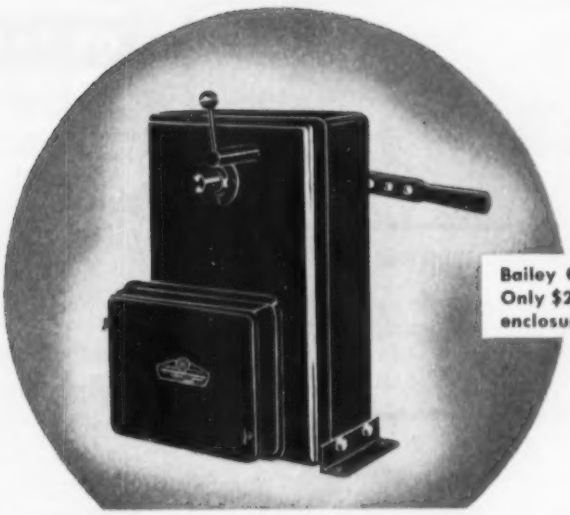
The plant, Kerr-McGee's newest and most modern natural-gasoline installation, processes some 57 Mmcf. of gas a day, producing 60,000 gallons of raw de-ethanized gasoline.

Bureau to Abandon Use of Saybolt Units

Bureau of Standards will abandon the use of master Saybolt viscometers as standards for the calibration of Saybolt Universal and Saybolt Furol viscometers. Saybolt viscometers are widely used in the petroleum industry to measure viscosities of lubricating and fuel oils.

Years ago, these master instruments were adopted in cooperation with the American Petroleum Institute's Committee on Viscosity Standards, as representing Saybolt instruments having normal flow times. The master instruments have been in the custody of the bureau, and used to determine corrections to be applied to the flow times of instruments submitted for certification.

More recently, the American Society for Testing Materials has published standard conversion tables and factors for the conversion of kinematic viscosities to Saybolt viscosities. Because of the greater precision



Bailey Control Drive, Type AC44P Model 200. Only $210.00 F.O.B. Cleveland, complete with enclosure, positioning relay and hand operator.

Want Better Flow Characteristics from Your Regulating Devices?

This new, small, piston-operated Bailey Control Drive will improve the flow characteristics of butterfly valves, dampers, hydraulic couplings, feeders and similar regulating devices. Adjustment is simple; any desired relation between drive motion and pneumatic signal may be secured.

You can install this compact pneumatic drive power unit in any position on a column, pipe, or flat surface—and connect it to the regulating device with standard Bailey linkage, available from stock.

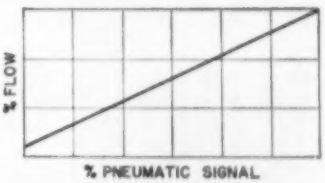
Speed (time required for full travel) is adjustable to suit your requirements. Bailey Control Drives operate on standard SAMA pneumatic signal ranges of 3 - 15 or 3 - 27 psig.

AVAILABLE FROM STOCK in 3 standard sizes

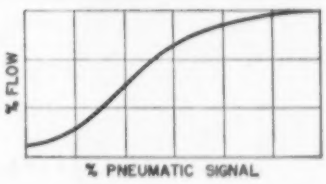
Type	Piston Dia. Inches	Piston Stroke Inches	Torque ft-lb	Max. Travel Degrees	Approx. Dimensions Inches
AC816	8	16	1500	90	13 x 27 x 51
AC68	6	8	400	90	13 x 19 x 34
AC44	4	4	75	75	10 x 11 x 19

P-28

The New Bailey Control Drive gives you THIS—



instead of THIS



BAILEY METER COMPANY

1043 IVANHOE ROAD

CLEVELAND 10, OHIO

Complete Controls for Process Plants

BAILEY METERS

Controls for

TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW LEVEL
RATIO

FOR MORE INFORMATION
FILL OUT AND MAIL

☐ I am interested in Bailey Control Drives. Mail me Spec. P81-1.

☐ I am interested in Bailey Control Linkage. Mail me Spec. P81-5.

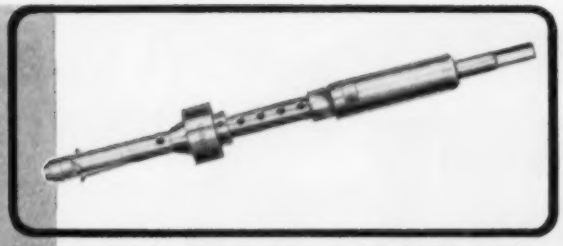
Name_____

Title & Company_____

Street & Number_____

City & Zone_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

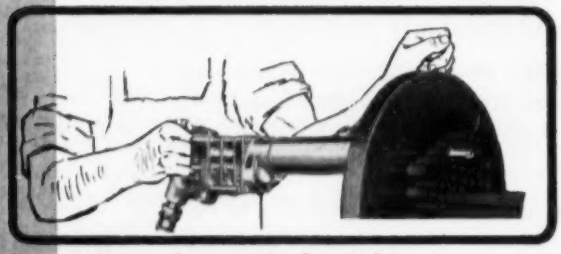


Now—a new push-type internal Tube Cutter

A time-saving maintenance tool that may be used with your present air or electric motor to cut non-ferrous tubes.

Easily carried. A must in every tool box.

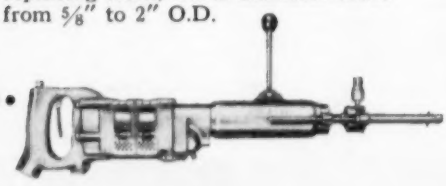
Many uses in every plant. Action of cutting blades is produced by pushing cutter into the tube which automatically opens the double cutter blades.



Works wonders when replacing tubes

Extremely useful. Saves time when replacing worn, small diameter tubes from ⅝" to 2" O.D.

Also furnished with motor and lever operator

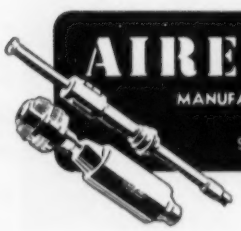


An air-driven type internal tube cutter is available for production use. Cuts non-ferrous tubes 2-4 seconds each. Steel tubes 8-12 seconds each. Literature and complete details upon request.

BRANCH OFFICES: New York, Chicago, Philadelphia, Tulsa, Houston, Baton Rouge. Representatives in principal cities of U.S.A., Canada, Mexico, England, South America and Japan.

EUROPEAN PLANT: Airetool Nederland, N.V., Vlaardingen, The Netherlands.

"There's an Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction."



AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

What's Happening. . .

in determining kinematic viscosities, these tables and factors provide more precise definitions of the Saybolt viscosity scales than do the master instruments.

Consequently, continued use of the master instruments has become unnecessary and according to the bureau, technically undesirable. They will be abandoned as standards after June 30, 1956.

Any objections to this action should be brought to the attention of the director of the National Bureau of Standards.

Jersey Standard Company Profits Hit Record High

Profits of Standard Oil Company (New Jersey) set a new over-all record for 1955. An estimate by the company's president, M. J. Rathbone, places profits for the year at $717 million. Consolidated net income for 1954 ran $585 million.

During 1955, affiliated companies reached new level highs in refining; petrochemicals, at a level above the previous year, accounted for about 6 percent of the company's total income.

Rathbone said net income of the Jersey Standard group at the end of 1955 was about $4700 million. He believed the company and its affiliates had spent about $850 million during the year for new plant and equipment, and predicted that the group's investment program in 1956 would total $1200 million.

According to the president, adding one barrel of capacity to the Standard group costs about $4000.

Regarding the expansion of refining facilities in 1956, Rathbone said plants will be enlarged in Cuba and the United Kingdom, and that new refineries will be built in Colombia, France, Germany and the Far East.

Safety Stressed at Rifle

Bureau of Mines is using the government's oil-shale mine at Rifle, Colo., as an underground laboratory for mining research. The bureau is studying rock movement, ventilation, drilling, blasting, automation and other related subjects. Backed by a $1-million appropriation, the agency is stressing safety and economy of operation in its new work at the experimental mine.

Wisconsin Plant on Stream

Empire Petroleum Company has gone on stream with its recently-acquired Sheboygan, Wis., refinery. Formerly owned by Wisconsin Oil Refining Company, the 5000-barrel-a-day refinery had been closed down.

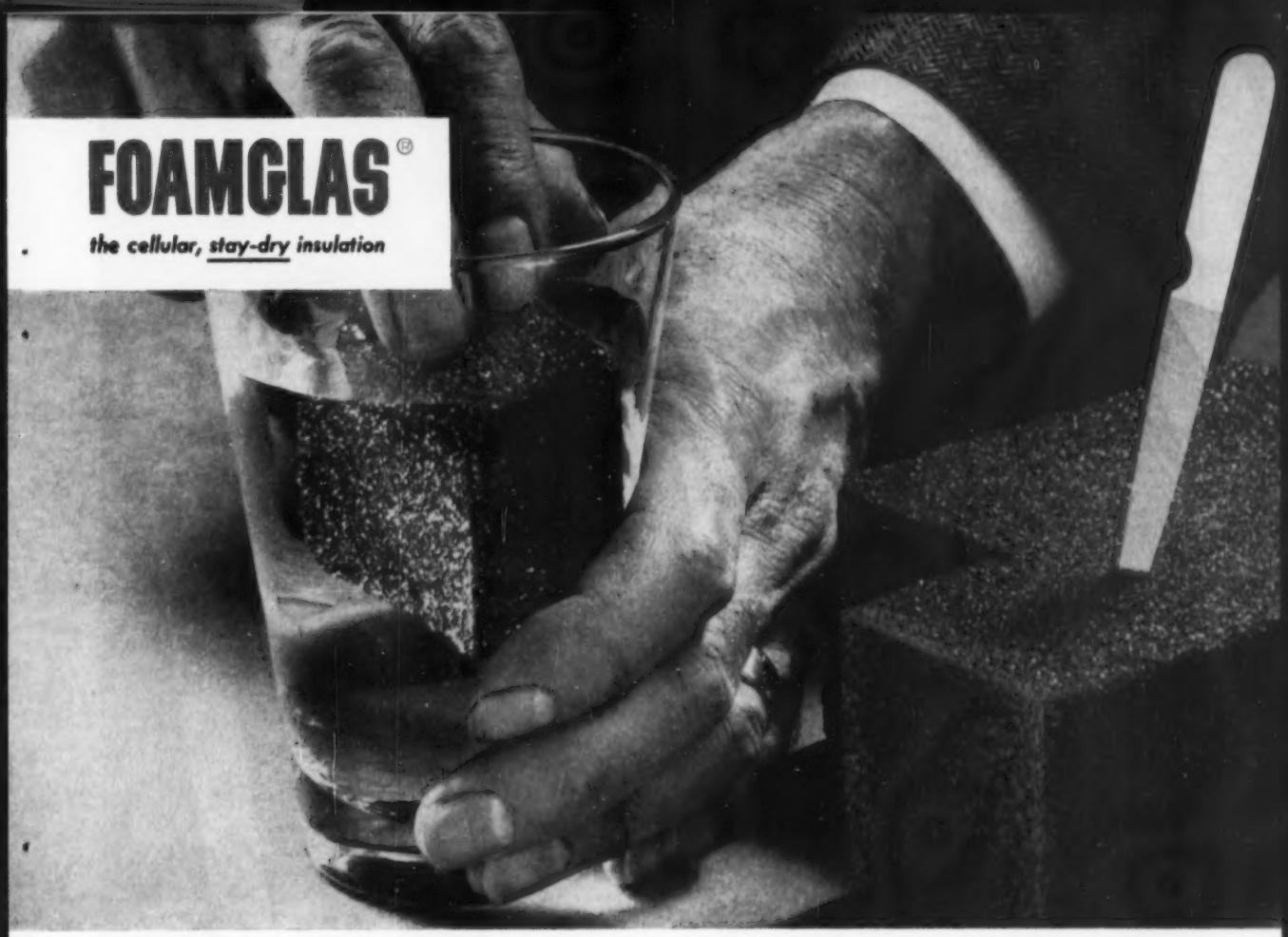
Research Costs Expected To Total $5 Billion

Industrial research outlays in 1956 will run more than $5 billion, according to a prediction by E. Duer Reeves, executive vice president of Esso Research and Engineering Company. He has based this prediction on the widespread recognition of research as an integral part of business activity.

Of the amount spent for research in most companies, Reeves estimated that only about 10 percent is used to accomplish creative work. The rest of the cost,

FOAMGLAS®

the cellular, stay-dry insulation



STAYS DRY—Cut a piece from your sample. Place it in water. Note how the hermetically-sealed glass cells filled with dead air keep it afloat. Weight it down for days, weeks or longer if you like. Remove the weight and it bobs back to the surface . . . proof that the sealed cells have absorbed no water, still have their original insulating efficiency.

Send for a sample and make these simple tests!

Prove to yourself that FOAMGLAS is your ideal insulation!

Let us send you a free sample of FOAMGLAS. Use it to make the few simple tests illustrated. You'll prove that this unique cellular glass insulation has exactly the right combination of properties to assure you of these vital benefits: constant insulating efficiency . . . long, maintenance-free life . . . strength and rigidity for a variety of structural applications . . . and ease of handling and installation.

Thousands of users have proved in actual performance the benefits so clearly demonstrated by these tests. No wonder, then, that new users every day are picking FOAMGLAS to insulate the roofs, ceilings, walls and floors of all types of buildings, low temperature spaces, piping and equipment. Send for a sample today and make your own tests. Please write . . .

Pittsburgh Corning Corporation
Dept. Z-26, One Gateway Center
Pittsburgh 22, Pa.
In Canada: 57 Bloor St. W., Toronto, Ontario

VAPOR-PROOF—With a nail file, cut a ¼" thick slice from your sample. Hold it to your lips and try to blow smoke through it. The smoke won't penetrate . . . proof that FOAMGLAS is a positive vapor barrier in itself.

STRONG AND RIGID—Place your FOAMGLAS block on the floor. Stand on it. Note how it supports your weight without crushing. Compressive strength is over seven tons per square foot . . . making it ideal for load bearing applications.

INORGANIC AND FIREPROOF—Hold a flame to your sample. You'll see at once that it does not burn . . . a major safety feature in all construction. It's even acid-proof and rodent-proof as you can prove if you happen to have a vial of acid or a pet rat handy.

LIGHT WEIGHT—Just pick up your sample to see how light and easy to handle it is. Check actual weight on your company's postal scale if you wish. The density of FOAMGLAS is only 9 pounds per cubic foot.

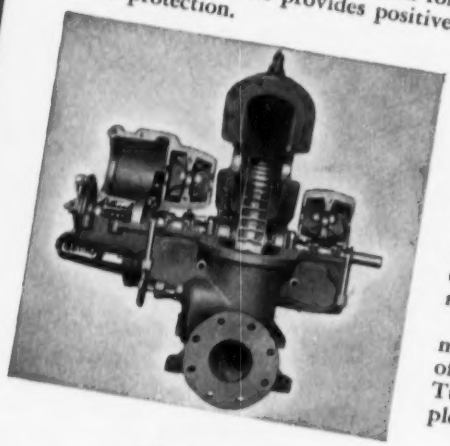
EASY TO SHAPE AND CUT—Shave some strips off your sample with an ordinary paper clip . . . workmen use knives, saws or trowels for quick shaping and fitting on the job.

TERRY

PROTECTION OF TURBINE BLADES made possible by nozzle location

The Terry Solid-wheel Turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.

In the Terry Solid-wheel Turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.



The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many important features of the Terry Solid-wheel Turbine. Write for complete details.

TT-1195

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

he felt, could be charged to such supporting services as construction and maintenance of facilities; the work of mechanics, operators, laboratory assistants, stenographers and file clerks; engineering work and field tests, and various management activities.

Tom W. Nelson

Robert de Sombre

Gulf Publishing Names New Management Team

Effective last January 1 Gulf Publishing Company started a new management team. Tom W. Nelson, for many years a vice president of the company, was made general manager, Robert de Sombre, formerly circulation director, was made assistant general manager.

The new manager and assistant general manager succeed A. L. Burns who has been general manager of the Gulf Publishing Company for 31 years. Burns, although he remains on the board of Gulf Publishing Company and will be a member of the advisory committee of that company will devote his full time to the Gulf Printing Company, an allied company which operates one of the largest printing establishments in the Southwest.

A. L. Burns

Tom Nelson, new general manager, first became associated with Gulf Publishing Company in 1922. He is a past president of Nomads and a national regent of that organization. His work as an executive and in the Sales department of the company has brought him in touch with oil men and manufacturers throughout the U. S. and England.

Robert de Sombre has been on Gulf Publishing Company's executive staff for the past five years as director of circulation.

It was also announced that Douglas Craig had been named advertising manager of WORLD OIL and PIPE LINE INDUSTRY and the COMPOSITE CATALOG of Oil Field Equipment.

In the Circulation Department, Ted Gaden was made manager of fulfillment and Bob McNeil was made manager of procurement for the Circulation department.

The executive staff of Gulf Publishing Company now comprises:

Ray L. Dudley, president and publisher of the company's three oil publications, *World Oil*, *Pipe Line Industry* and PETROLEUM REFINER.

Tom W. Nelson, executive vice president and general manager.

Robert M. de Sombre, vice president and assistant general manager.

Warren L. Baker, vice president and Editorial Director, *World Oil*.

Pat Aucoin, treasurer.

Silas B. Ragsdale, editorial director, PETROLEUM REFINER.

Douglas Craig, sales manager, Division 1.

Ted Gaden, manager of fulfillment, Circulation.

Bob McNeil, manager of procurement, Circulation.

The board of directors consists of James A. Anderson, P. J. Aucoin, Warren L. Baker, A. L. Burns, R. M. de Sombre, F. G. Dudley, Ray L. Dudley, William G. Dudley, Charles H. Lane, John J. McKetta and Tom W. Nelson.

Two Join Institute

Two more refining companies have been admitted to membership in the Asphalt Institute. Applications were approved for Sun Oil Company and Richfield Oil Corporation, bringing to 53 the number of members in the institute.

Refining Profits Up

Profits for the petroleum-refining industry showed a gain for the first nine months of 1955. According to a report from the Federal Trade and Security and Exchange Commissions, profits for the period, after taxes, ran $1,741,000,000. This was compared to the $1,568,000,000 reported for the same period in 1954.

TC

CUPRIC CHLORIDE

PRODUCED BY THE

TENNESSEE CORPORATION

MINERS OF COPPER, ZINC, IRON AND SULFUR.

For Removal of Sulfur Compounds in Petroleum Refining.

CONTRACT REQUIREMENTS SOLICITED . . .

We are in a position to supply your needs on annual, semi-annual, or monthly contract basis—also smaller quantities in drop shipment lots.

CUPRIC CHLORIDE DI-HYDRATE

TYPICAL ANALYSIS

Copper	37.00%	Minimum
Moisture	12.00%	Maximum
Fe	.04%	Maximum
Zn	.01%	Maximum
Water Soluble	more than 99.50%	
Insoluble as copper oxychloride	less than .50%	

FOR

1. Quality Improvement
2. Cost Reduction

Other Tennessee Corporation products, Ferric Sulfate (Ferri-Floc), Copper Sulfate, and Sulfur-Dioxide.

For Samples . . . Make request on your company letterhead.

CHECK THESE FEATURES:

√	HIGHER COPPER CONTENT
√	LOWER MOISTURE
√	FINER PARTICLE SIZE
√	UNIFORMITY
√	AVAILABILITY

TENNESSEE TC CORPORATION

617-29 Grant Building, Atlanta, Georgia

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

. . . *Among Men* in the Industry

Copeland

Flynn

William G. Copeland has been appointed manager of The Texas Company's Operations division of the Refining department in New York. He succeeds **Howard S. McCray**, recently named manager of the Purchasing department.

Formerly general superintendent of the Texaco refinery at Port Arthur, Texas, Copeland will be succeeded by **Henry Flynn**, who was superintendent of manufacturing. Moved up to take Flynn's place is **H. E. Fouts**, assistant superintendent of manufacturing.

Copeland, who joined the Refining department in 1927, had been general superintendent at Port Arthur since early 1954. He also had served four years as superintendent of the Eagle Point works at Westville, N. J., and previously had been superintendent of the company's Sunburst, Wyo., refinery.

Flynn has been superintendent of manufacturing at Port Arthur since 1953. He joined The Texas Company in 1927 and two years later was transferred to Port Arthur. He became assistant superintendent of manufacturing in 1944.

Fouts has been assistant superintendent of manufacturing since 1953. Before that, he served eight years as supervisor of lubricating oil and grease processing. He joined Texaco at Port Arthur in 1931.

E. D. Kelly, since 1952 director of the Federal Facilities Corporation's Office of Synthetic Rubber, has joined George Armistead and Company as administrative director. The company is an international firm of engineers headquartered in Washington.

Harlan W. Nelson, chief of the Fuels and Combustion Research division at Battelle Memorial Institute in Columbus, Ohio, has been elected chairman of the American Chemical Society's division of Gas and Fuel Chemistry.

Dr. Nelson joined the institute in 1944 as a research engineer in its Fuels division and, after seving as supervisor of fuels research, was named chief of the Fuels and Combustion Research division in 1951. Before joining the institute, he was a member of the faculty at Pennsylvania State University.

T. S. Leary has been appointed manager of Cities Service Research and Development Company's Process Development laboratory in Lake Charles, La.

Lucien O. Crockett has been elected a vice president of Gulf Oil Corporation. A veteran of nearly 35 years with the company, Crockett has been general manager of its Chemical department. In his new position, he will continue to direct the activities of this department.

Crockett started with Gulf in 1922 as a laboratory assistant at its Port Arthur, Texas, refinery. He later served as a foreman, and in 1934 was named chief chemist for the three Gulf refineries then operated in Texas. He was appointed assistant general superintendent of the Texas refineries in 1945.

In 1950, he was transferred to the general offices in Pittsburgh, where he served first as manager of the Manufacturing department's Technical division and subsequently as manager of the Petrochemical unit. He was made general manager of the Chemical department when that unit was organized in 1955.

Walter Henry Nelson has been appointed editor of the *API Quarterly*. Nelson, who has been a member of Information department staff for the past year, succeeds **Miss Eloise Michel,** who retired. Assisting the new editor will be **Edward D. Mellinger,** another member of the department, who was appointed consulting editor.

Basil R. Jackson, deputy chairman of the board of The British Petroleum Company, Ltd., is being moved up to chairman. He succeeds **Lord Strathalmond,** who is retiring after 33 years as a director and 28 years as either chairman or deputy chairman of the board.

Jackson

Named to replace Jackson as deputy chairman is **Neville A. Gass,** a managing director of the company since 1939. **Maurice Bridgeman,** onetime British Petroleum representative in New York, will be appointed to the board, filling the vacancy created by Lord Strathalmond's retirement.

The new chairman was elected a director of British Petroleum in 1948, after 15 years as manager of the company's New York office. During World War II, he was appointed by the Petroleum Administrator for War as one of two British representatives on the Foreign Operations Committee.

Hugh T. Campbell has been promoted to senior mechanical engineer in the Design department of the Engineering division at Humble Oil & Refining Company's Baytown, Texas, refinery. He supervises a group concerned with mechanical design work on equipment throughout the refinery. Campbell holds a B.S. degree in mechanical engineering from Southern Methodist University.

Bond

Rothrock

George L. Bond and **E. S. Rothrock** have been elected directors and vice presidents of the Stauffer Chemical Company. Bond was formerly president and Rothrock, executive vice president of Consolidated Chemical Industries Inc., which was merged with Stauffer. Rothrock has been appointed general manager of Stauffer's Consolidated Chemical Industries division.

Dr. Hermann Carl Gotz has received an award citing his achievements in the field of science and industry and his services for the development of the German oil industry. The award was the Carl Engler Medal, presented by the Deutsche Geselschaft fuer Mineraloelwissenschaften und Kohlechemie e. V.

Dr. Gotz was first employed as a chemist at the Wedel refinery of Deutsche Vacuum Oel Aktiengesellschaft in 1908, and later became superintendent of that refinery and the Bremen-Oslebshausen refinery.

From 1929 to 1938, he was a member of the Manufacturing committee of Socony Mobil Oil Company, Inc. In this capacity he supervised the company's refineries in Germany, Austria, Hungary, Poland, Czechoslovakia and Yugoslavia, and for a while in France and Italy.

In 1938 he was appointed to the board of directors of Deutsche Oel Aktiengesellschaft in Hamburg. He retired in 1948 and from then until 1951, served as an advisor to D. V. O. A.

J. E. Lawson has been promoted to senior chemical engineer in the Technical Service division at Humble Oil & Refining Company's Baytown, Texas, refinery. At present on a training assignment in Humble's Executive Development program, he is directing the efforts of technical personnel engaged in crude distillation.

J. T. Higgins has been appointed general manager of operations in the Manufacturing department of Standard Oil Company of California. Higgins, who has been president of two Salt Lake City subsidiaries, will succeed **Francis H. Smith,** who retired after 43 years with the company.

With California Standard since 1929, Higgins was a specialist and foreman at the El Segundo, Calif., refinery until 1937. Since then he has held supervisory and managerial posts at the Richmond, Calif., refinery and the home office in San Francisco.

Before his assignment in Salt Lake, he

PETROLEUM CHEMICALS DIVISION
NEWS

February ★ One of a Series of Interest to the Petroleum Industry ★ 1956

Question Box

Want to get your TEL-handling people to think of safety "as a way of life"? Then you'll be interested in reading about the Du Pont Lead Hazard Clinic.

What makes a construction safety program, and what are the returns on a safety investment? To obtain a print of the movie that gives the answers, see the article on our film, "Builders of Tomorrow."

Who heads the Petroleum Chemicals Division Eastern Regional Lab? We'd like you to meet *Ed Jeffus.*

Have you heard about the oil industry's "best seller"? See the story about "Speak to the Earth."

THE DOLLARS AND CENTS OF SAFETY

New film of interest to refinery construction personnel

"The Builders of Tomorrow" is the title of a film about accidents that never happened. More importantly, it illustrates how and why they never happened.

This 28-minute color movie was made on location as the Du Pont Engineering and Construction Division erected the A.E.C.'s Savannah River Atomic Energy Plant in Aiken, S. C.

This plant, a 4½-year task, involves massive equipment, thousands of workers and many different hazards. It is one of the largest and safest construction undertakings in history.

In one period of over 6,000,000 work hours, not a single disabling injury occurred. The safety record achieved at Savannah River was 36 times better than the national average for this type of work.

Of interest to refiners

Many safety problems, similar to those encountered in the oil industry, were solved on this project. "The Builders of Tomorrow" should prove stimulating to engineers, supervisors and others concerned with construction safety. For this reason, the Du Pont Petroleum Chemicals Division has obtained prints of the film. Any sales office will be glad to arrange showings.

Du Pont Lead Hazard Clinic helps promote safe TEL handling through education

Because the dangers inherent in the use of tetraethyl lead are of a serious nature, the Du Pont Company, as supplier of this compound, offers refiners a program to help maintain safe handling operations. Originated in 1951, the program is called the Du Pont Lead Hazard Clinic. A review in January, 1956, showed that Du Pont had presented the clinic 280 times for 44 oil companies before a total audience of 7,787 persons.

Refinery personnel whose work brings them into proximity with TEL learn about the Du Pont Lead-in-Air Analyzer. Slides and booklets help make the Du Pont Lead Hazard Clinic easy to understand.

The clinic is available to all refiners. It is suitable as a refresher course for refinery, marketing, pipeline and terminal supervisory personnel and as a supplement to your own training courses.

Your problems discussed

The six sections of the clinic program cover the toxic properties of TEL, the source of TEL tank cleaning and repair hazards, safe cleaning practices, demonstration of the Du Pont Petroleum Chemicals Division Lead-in-Air Analyzer, a question and answer period, and a summation.

A way of life

Called "Something Else Is Necessary," the summation is delivered by the Petroleum Chemicals Division Medical Director. It emphasizes to the individual his own responsibility in

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED **Hazard Clinic**

achieving safe TEL handling . . . in making safety "a way of life."

Experience has shown that the question and answer period offers one especially important benefit to your employees. It gives them a chance to get detailed answers to particular problems from men with extensive experience in every facet of TEL handling.

Visual aids

In easy-to-remember form, a slide presentation shows graphically the safe procedures and recommended precautions for tank entry work. This part of the clinic program is followed by a 5-minute demonstration of the Du Pont Lead-in-Air Analyzer.

A booklet, "Tank Talk," recaps the clinic and a copy is given to each member of the audience. Over 20,000 copies have been distributed and the booklet is now in its third printing.

Available to all

In the interest of sound preventive medicine and good industrial safety practice, Du Pont makes this clinic available to all oil companies. It is recommended for supervisory personnel currently concerned with TEL handling procedures, and to others who may in the future be assigned to this area of operation. To keep their programs up to date, some refiners have set up repeat clinics on an every-other-year basis.

If you would like further information about the Du Pont Lead Hazard Clinic, consult your local Du Pont Petroleum Chemicals Division representative.

HEADS PETROLEUM CHEMICALS DIVISION EASTERN REGIONAL LAB

Ed Jeffus joined the Du Pont Petroleum Chemicals Division in 1950 and was appointed Eastern Regional Laboratory Manager in January 1952. As manager, he works closely with refiners and provides technical services which are directed toward the more efficient utilization of petroleum additives.

Prior to joining Du Pont, Jeffus was a chemist at the Shell Oil Company's refinery at Norco, Louisiana.

His entry into the petroleum industry followed schooling at Magnolia A. & M., Magnolia, Arkansas, M. I. T., and ending with a B. S. in chemistry at the University of Arkansas in 1948. During World War II, he was a meteorologist in the U. S. A. F. and served a 25-month overseas tour in England and France.

Originally from Texarkana, Arkansas, Ed now lives in Wilmington, Delaware with his wife and two children. His hobbies include hunting, fishing, skeet and bridge.

EDISON D. JEFFUS

Mr. Jeffus is a member of the American Chemical Society.

"Speak to the Earth" in Third Edition

Appleton-Century-Crofts, Inc., publishers, have announced a new printing for "Speak to the Earth," a book about the oil industry. The writing of this book was commissioned by the Du Pont Company.

The initial printing was a de luxe edition which was exclusively distributed by the Du Pont Petroleum Chemicals Division. At the same time, a standard edition was produced and marketed to the public by the publisher. This has been sold out.

Of the edition now in printing, 1500 copies will be used by the O.I.I.C. The remainder will be available through regular book stores.

Written by Max Miller, "Speak to the Earth," was first introduced in June, 1955.

DU PONT

Better Things for Better Living
. . . *through Chemistry*

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.) *Petroleum Chemicals Division • Wilmington 98, Delaware*

Sales Offices:

CHICAGO, ILL.—8 So. Michigan Ave. Phone RAndolph 6-8630
HOUSTON, TEXAS—705 Bank of Commerce Bldg. Phone CApitol 5-1151
LOS ANGELES, CAL.—612 So. Flower St. Phone MAdison 5-1691
NEW YORK, N. Y.—1270 Ave. of the Americas Phone COlumbus 5-2342
PHILADELPHIA, PA.—3 Penn Center Plaza Phone LOcust 8-3531
PITTSBURGH, PA.—Room 510, Alcoa Bldg. Phone ATlantic 1-2933
SAN FRANCISCO, CAL.—Room 626, 111 Sutter St. Phone EXbrook 2-6230
SEATTLE, WASH.—Room 215, 4003 Aurora Ave. Phone MElrose 6977
TULSA, OKLA.—P. O. Box 730 Phone LUther 5-5578

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division—80 Richmond Street West—Toronto 1, Ontario
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Bldg. 6539—Wilmington 98, Delaware

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-751

Printed in U. S. A.

What's Happening. . .

was manager of operations at Richmond. At Salt Lake, he was president of Salt Lake Refining Company and Salt Lake Pipe Line Company.

Robert E. Yancey has been elected vice president in charge of all refining operations for Ashland Oil & Refining Company. With the company since 1943, Yancey has served successively as technical-service engineer, process engineer, shift superintendent, operating superintendent of both Ashland refineries at Catlettsburg, Ky., refinery coordinator, and just previous to his election, he was general superintendent of refineries.

Ralph D. Patch, head of the Petroleum Products division of Esso Standard Oil Company's Baton Rouge, La., refinery, has been an executive assignment as advisor of the management of the Hamburg refinery of Esso A. G., German affiliate of Standard Oil Company (New Jersey).

Patch

D. M. Cox, head of the Baton Rouge refinery's Technical division, succeeds Patch as head of the Petroleum Products division. Cox will be succeeded in the Technical division by **R. K. Dix,** head of the Crude and Products Coordination department.

Patch joined the Esso Standard refinery in 1932, as a laboratory assistant. He became head of the refinery's Process Engineering department in 1934 and four years later, was named technical assistant to the general superintendent.

In 1942, he was promoted to coordinator of government projects and in 1946, was named assistant manager of the Chemical Products division. He became head of that division in 1951. He had been head of the refinery's Petroleum Products division since 1954.

A. R. Dudley has been promoted to senior chemical engineer in the Technical Service division at Humble Oil & Refining Company's Baytown, Texas, refinery. He will be responsible for technical control and long-range planning of various units used in the manufacture of lubricating oils.

Byron E. Milner, head of the Licensing section of The Atlantic Refining Company, has been appointed technical assistant to the vice president and general manager of manufacturing. **John A. Nevison,** assistant head of the Licensing section, was named to succeed Milner.

Milner joined Atlantic in 1939 at its Philadelphia refinery. He was transferred to the company's Research and Development department in 1942, and in October 1953, was advanced to head the Licensing section.

H. W. Earhart has been promoted to senior research chemical engineer in the Research and Development division of the Humble Oil & Refining Company at Baytown, Texas. He will engage in research in the petrochemical field, particularly on methods for increasing supplies of specialized hydrocarbons by chemical synthesis.

Kasch

Feuchter

John E. Kasch, for the past two years a technical assistant to The American Oil Company's vice president of manufacturing, has been appointed manager of coordination in the Manufacturing department. Also receiving a new assignment in the department is **Charles F. Feuchter,** named manager of planning.

Feuchter joined the parent Standard Oil Company (Indiana) in 1935 as a chemical engineer. Three years later he was transferred to the company's refining affiliate in Texas City, Texas, where he held a variety of positions in the Manufacturing department.

He was moved to New York in 1942 and later held a number of key positions in the Manufacturing department. In 1952, Feuchter served as special assistant to the director of refining of the Petroleum Administration for Defense.

Dr. Kasch joined the refining affiliate at Texas City in 1942 as a chemical engineer. While there he held various positions in the Manufacturing department.

He was transferred to New York in 1952 to serve as technical assistant to the president of the affiliate, and for the past two years he has been technical assistant to the vice president of manufacturing. During World War II, Dr. Kasch served in the refining division of the Petroleum Administration for War.

W. O. Twaits, since 1952 a vice president of Imperial Oil, Ltd., has been promoted to executive vice president. Named as a director of the company was **J. A. Cogan,** formerly manager of coordination and economics for Standard Oil Company (New Jersey). Their appointments follow the retirement of **G. L. Stewart,** chairman of the board. Stewart had been with the company 39 years, 11 of which were spent as a director.

James R. Keith has gone to the Bahrain Archipelago, to replace **Carlton R. Barkhurst** as general manager of The Bahrain Petroleum Company, Ltd. Barkhurst, assigned to Bahrain since 1937, will return to New York to assume new duties with the Refining division of California Texas Oil Company, Ltd.

Keith started with The Texas Company at its Port Arthur, Texas, refinery in 1929 and later served the Managerial division in New York until 1936, when he joined the newly-formed Caltex Group. Since then he has been engaged in research and development work with the Refining division. In 1952, he was promoted to assistant vice president and assistant general manager of the division.

Barkhurst, who also started with Texaco at Port Arthur in 1929, was advanced to chemical engineer and mechanical engineer in the Refining division. At Bahrain, he became refinery superintendent in 1942, manager of refining in 1947, assistant general manager of operations in 1952 and general manager in 1953.

Conger Reynolds, for 26 years director of public relations for Standard Oil Company (Indiana), has retired to become chief of the Office of Private Cooperation of the U. S. Information Agency. Reynolds was granted retirement ahead of time to enable him to enter public service.

He will be succeeded as head of Standard's Public Relations department by **Don Campbell,** who was assistant director. Other executive changes in the department include the appointments of **James M. Patterson,** another assistant director, to director of field services; **John Canning,** also an assistant director, to director of information services, and **Robert Siebert,** copy chief, to editorial director.

Ernest L. Sinclair, manager of Socony Mobil Oil Company's Refinery Engineering division, heads a group reorganized to facilitate handling the division's increased work load under an accelerated refinery-construction program. Under the new plan, four subdivisions were created, each headed by an assistant manager.

- **Ernest Utterback,** formerly chief mechanical engineer, will head the Project section.
- **Vernon O. Bowles,** who was chief process engineer, will be in charge of the Development section.
- **Andrew K. Brumbaugh,** former project manager for construction of Standard-Vacuum Oil Company's Altona, Australia, refinery, was given charge of the Design section.
- **Benjamin F. Hartmen,** formerly technical director at Socony Mobil's Augusta, Kansas, refinery, was appointed head of the General Engineering section.
- **Austin C. Brightman,** who has been chief project engineer, was appointed as Sinclair's administrative assistant.

Other personnel changes include the appointment of four project engineers in the Project section. They are **Roy M. Owens,** former chief foreign project engineer; **D. G. Van Tilburg,** who has been process engineer; **R. E. Redfield,** who was chief maintenance and corrosion engineer, and **James I. Lawrence,** formerly chief engineer at Socony Mobil's Paulsboro, N. J., refinery.

C. L. Moore, formerly assistant general superintendent of El Paso Natural Gas Company, has been named vice president and general manager of a newly-organized affiliate, El Paso Natural Gas Products Company. The new concern was formed to operate the New Mexico refineries recently acquired by El Paso Natural Gas. (See What's Happening.)

Also elected a vice president was **Cecil E. McNutt,** one of the former owners of McNutt Oil & Refining Company. He will be operating manager of the newly-acquired refineries.

Clarence G. Petersen, now manager of dispatching at Shell Oil Company's Wilmington-Dominguez, Calif., refinery, will be advanced to assistant superintendent, succeeding **R. H. Tubman,** who is being transferred to the company's head office in New York.

Max F. Smith, manager of the refinery's Thermal-Cracking department, has been named to replace Petersen in the Dispatching department. Succeeding Smith will be **Clarence S. Bennett,** picked to move up from assistant manager of catalytic cracking.

With Shell since 1935, Petersen was made manager of its control laboratory at Martinez, Calif., in 1944. Transferred to the Wilmington-Dominguez plant in

1947, he has served as manager of the Thermal Cracking, Alkylation and Dispatching departments.

Smith joined Shell in 1943; his subsequent service included laboratory, technological and operating assignments and a period with the Shell organization in France. Bennett has been with the company since 1943 and handled various technological and operating assignments.

J. W. Alliston has been promoted to senior chemical engineer in the Technical Service division at the Baytown, Texas, refinery of Humble Oil & Refining Company. He will be engaged in chemical-engineering design work and processing studies relating to aromatic solvents product.

James H. Lewis, former president of Sunset Oil Company, has been elected executive vice president and general manager of the Independent Refiners Association of California. He succeeds the late **Donald B. O'Neill.**

Robert E. Wilson, chairman of the board of Standard Oil Company (Indiana), is chairman of the Petroleum and Natural Gas division of the Committee of American Industry, a division of the National Fund for Medical Education. The group is leading an appeal to raise $10 million a year for the nation's 81 medical schools. Serving with Wilson on the committee are 20 other members, all of them presidents or directors of prominent oil, gas and refining companies.

"Alamask"

offers a complete and diversified line of reodorants for petroleum and allied products

No longer need the products of the petroleum industry inflict upon their users the obnoxious odors resulting from the mercaptans and sulfides in their processing.

Years of development work and product-testing have culminated in a complete line of Alamask® reodorants that can successfully mask the objectionable odors of many petroleum products. Check this table to see which Alamask reodorants will solve your malodor problems:

"ALAMASK"	GASOLINE FRACTIONS	ASPHALTIC COMPOUNDS	KEROSENE BLENDS	COAL SPRAY OILS	SPACE HEATERS	CUTTING OILS	CLUTCH OILS	DIESEL FUELS	JET FUJIOS	MINERAL SPIRITS	WAXES	RAPHTHA	BURNER OILS
AAM								X					
AO						X	X						
AR		X								X			
BGM		X											
BH						X	X						X
BUL				X	X			X			X		X
CC			X							X			
CE			X							X			
CX											X		
MS			X							X	X	X	X
0.19	X				X	X	X		X				X
0.20	X				X	X	X		X				X
TO									X				

Rhodia's chemists and engineers, experienced in odor abatement and waste disposal, will provide technical assistance to you in your efforts to correct malodors.

For complete information on these new, highly-effective reodorants, write today to Rhodia, Inc., Industrial Reodorants ("Alamask") Division, 230 Park Avenue, New York 17, N. Y.

Rhodia INC.

What's Happening. . .

John S. Pfarr, a vice president and director of Leonard Refineries, Inc., has been appointed administrative head of the company's Manufacturing department. His staff will operate three refining divisions, Leonard, Mid-West and Roosevelt.

Refinery managers of the three divisions are **T. J. Williams,** Roosevelt Oil and Refining division, who has been elected to the board of directors of Leonard; **Everett Thompson,** Mid-West Refineries division, and **Robert Pollard,** Leonard Refineries division.

Within the Engineering department of the Manufacturing division, four new appointments were made. **Gordon McCarthy** was named economics engineer; **Kenneth Buckler,** refineries engineer; **Charles Fiske,** technical director, and **Paul Mernitz** was made chief research chemist.

- Staff selections within the Mid-West Refineries division include **Robert Brown,** assistant refinery superintendent; **Ford Croton,** personnel manager; **Howard Fitzgerald, Stuart Morton, John McBride** and **Hollis Deloach,** all shift foremen; **George House,** maintenance superintendent; **Henry Walters,** safety superintendent, and **George Willey,** control chemist.
- Appointments for the Roosevelt Oil and Refining division went to **J. L. Foster,** assistant refinery superintendent; **Bruce Weber,** refinery engineer; **Frank Conors,** transfer loading and treating supervisor; **Ray Mitchell,** maintenance superintendent, and **Harry Ormiston,** chief control chemist.
- Leonard Refineries division made the following staff selections: **Clayton Weaver** and **Charles E. Fiske,** superintendents—operations; **W. F. Doughrty,** superintendent—maintenance; **Beryl Fleury,** asphalt-manufacturing superintendent; **John Chilikos,** assistant asphalt manufacturing superintendent, and **Robert Burke,** chief control chemist.

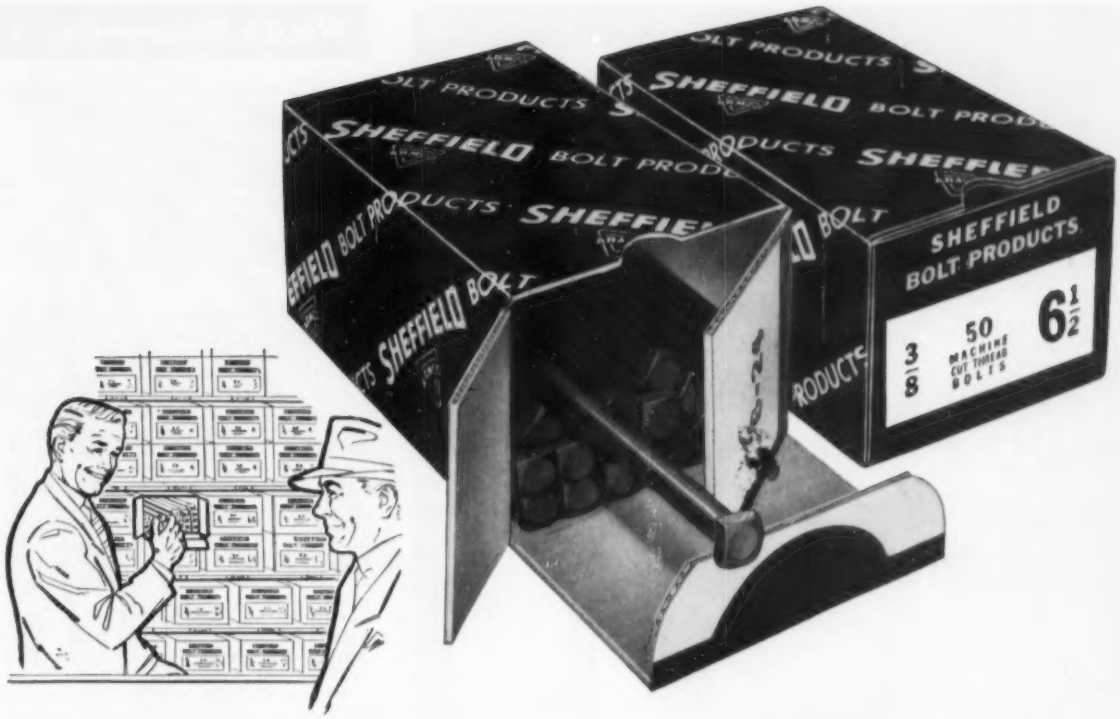
J. W. Morgan has been named general manager of manufacturing for The British American Oil Company. Morgan has been associated with British American's refining operations since joining the company at its Calgary refinery in 1939. For the past two years, he has been assistant manager of manufacturing at the head office in Toronto.

Woollen H. Walshe has been named a vice president of California Commercial Company, wholly-owned subsidiary of Standard Oil Company of California. He assumes direction of the company's Washington, D. C., offices succeeding **E. M. Burnham** who will retire. Burnham had been in charge of the Washington office since 1944.

Walshe joined the Standard of California organization at New Orleans in 1946 as an attorney for The California Company, also a Standard subsidiary. He was named general attorney for that company in 1951.

Henry D. Noll, formerly director of engineering for Houdry Process Corporation, has been appointed to a newly-created position as director of foreign operations. In his new position, Noll will present both Houdry's Process and Chemicals divisions.

With the company since 1944, he previously was with Socony Mobil Oil Company in its Research and Development laboratories at Paulsboro, N. J., where he was in charge of thermal and catalytic cracking. He started his career with Stand-



Sheffield Bolts For Every Oil Industry Need...

Now Available In New "serv-a-bolt" Packages!

Riggers, tool pushers, tank builders and maintenance crews all swear by Sheffield bolts because of their clean, precision-formed, free-running threads and their close tolerance fit.

Sheffield bolts now come packed in convenient "serv-a-bolt" packages, too—makes for easier handling all around . . . in the supply room . . . on the truck . . . and on the job!

These trim and sturdy dispenser-end cartons "serve" bolts fast without fuss or fumble. Cartons open with finger-flick ease—you take out as many bolts as you need without disturbing the stack.

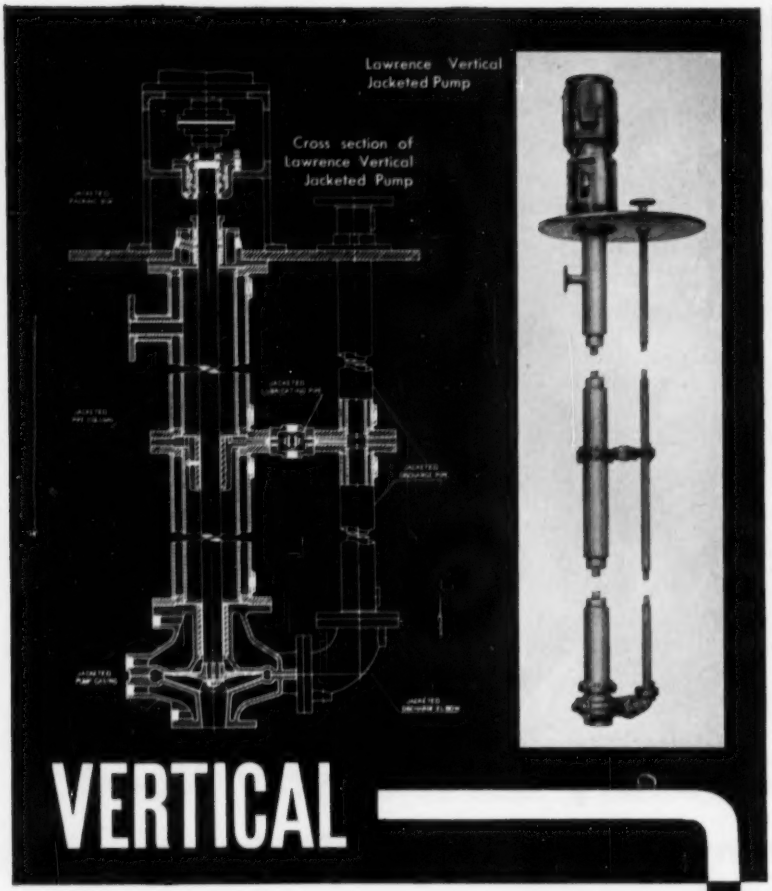
Look for this Sheffield package at your Oil Field Supply or Hardware store. Whether you want a single bolt, a carton or a case, you'll find them available in all sizes and for every oilfield requirement!

SHEFFIELD
ARMCO
Bolt Products

Be sure you keep a good variety of Sheffield bolts on hand for emergency requirements. Why not check your inventory now—then order what you need from your supplier?

SHEFFIELD STEEL
DIVISION
ARMCO STEEL CORPORATION
SHEFFIELD PLANTS: HOUSTON • KANSAS CITY • TULSA

For more data on advertised products, use Readers' Service Cards, last page.



VERTICAL

jacketed PUMPS

Lawrence vertical jacketed pumps are designed to pump liquids such as sulphur, phthalic anhydride, resins, waxes, etc., which tend to solidify or become viscous at low temperatures. The heating medium can be steam, dowtherm, etc.

The pump is jacketed throughout, i.e. — the pump casing, pipe column, discharge pipe and packing box. All heating spaces are vented and self-draining.

For submerged operation, these pumps are frequently made with only the pipe column, discharge pipe and packing box jacketed; the pump itself, not being jacketed.

If you have to pump liquids which must be maintained above a certain temperature to prevent solidification, write us the pertinent details. No obligation.

Write for Bulletin 203-7.

LAWRENCE PUMPS INC.
371 Market Street, Lawrence, Mass.

What's Happening. . .

ard Oil Company (New Jersey) and served Magnolia Petroleum Company as development supervisor at Beaumont, Texas, before he was moved to Paulsboro.

With Houdry, he has been manager of the Project Analysis section, head of the Engineering and Technical Service group, director of engineering and technical consultant to Houdry licensees. He is author of a number of articles on petroleum processes.

Warren Thompson, assistant director of D-X Sunray Oil Company's Research and Development department, has been named manager of the Company's Research and Technical Service department.

His was one of six major promotions involving key personnel in company's refinery operation. Appointments also involved three other men whose duties include administration of D-X Sunray refineries.

• **L. D. Stewart,** assistant general refinery superintendent at the West Tulsa, Okla., refinery, was made assistant manager of the Research and Technical Service department.

• **J. A. Middleton,** also an assistant refinery superintendent at West Tulsa, became manager of the Engineering Construction and Maintenance division.

• **Gayle Rodgers,** who was manager of the Technical Service department for Sunray Oil Corporation before the merger in 1955, was named administrative assistant to the executive vice president in charge of manufacturing. He will be in charge of operations.

Duties of all four involve operations at the Duncan, as well as the West Tulsa refinery. **D. G. Morgan** remains director of the Research and Technical Service division with offices at the Tulsa refinery.

Pierce Reynolds, chief process engineer, was promoted to second assistant superintendent of the Operating department at West Tulsa, and **Carl E. Larson,** first assistant superintendent of the Heavy Oil department there, was promoted to superintendent of lube in the Heavy Oil department at West Tulsa.

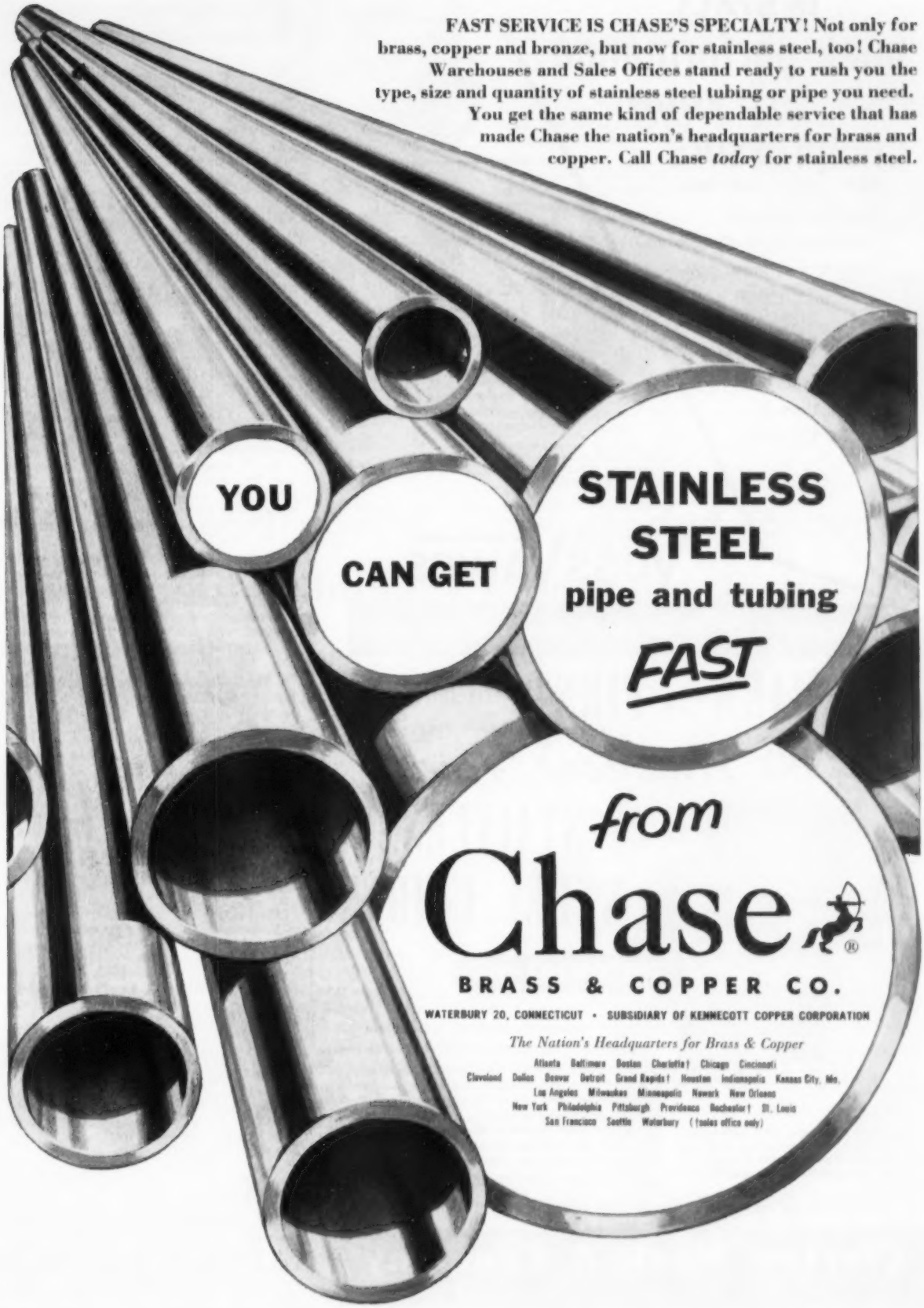
George A. Fowles, with The B. F. Goodrich Chemical Company, has been named director of the Business and Defense Services Administration's Chemical and Rubber division.

Walter J. Connor, vice president and director of American Plastics Corporation, has been appointed chairman of the Technical Conference on Plastics, to be held in New York June 11-15, 1956. His company is a subsidiary of Heyden Chemical Company. The conference, sponsored by The Society of the Plastics Industry, Inc., will be held in conjunction with the Seventh National Plastics Exposition, scheduled for the same week in New York.

Leonard Raymond, chief automotive engineer for Socony Mobil Oil Company, Inc., has been elected a vice president of the Society of Automotive Engineers. He will be in charge of the society's Fuels and Lubricants activities.

John S. Rearick has been elected vice president of The C. W. Nofsinger Company. Rearick joined the company in 1954 as manager of engineering. Before that he spent more than 16 years with The

For more data on advertised products, use Readers' Service Cards, last page.


FAST SERVICE IS CHASE'S SPECIALTY! Not only for brass, copper and bronze, but now for stainless steel, too! Chase Warehouses and Sales Offices stand ready to rush you the type, size and quantity of stainless steel tubing or pipe you need. You get the same kind of dependable service that has made Chase the nation's headquarters for brass and copper. Call Chase *today* for stainless steel.
YOU
CAN GET
STAINLESS STEEL
pipe and tubing
FAST
from
Chase
BRASS & COPPER CO.
WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION
The Nation's Headquarters for Brass & Copper
Atlanta Baltimore Boston Charlotte† Chicago Cincinnati
Cleveland Dallas Denver Detroit Grand Rapids† Houston Indianapolis Kansas City, Mo.
Los Angeles Milwaukee Minneapolis Newark New Orleans
New York Philadelphia Pittsburgh Providence Rochester† St. Louis
San Francisco Seattle Waterbury (sales office only)

For more data on advertised products, use Readers' Service Cards, last page.

INSTALL
peak performance
INTO YOUR
compressors
(AIR • GAS • AMMONIA)

Peak performance, maximum efficiency, greater output, and lower power costs can be built into your oldest, and of course your newest, compressors by the installation of VOSS VALVES.

Check THESE VOSS VALVE ADVANTAGES:

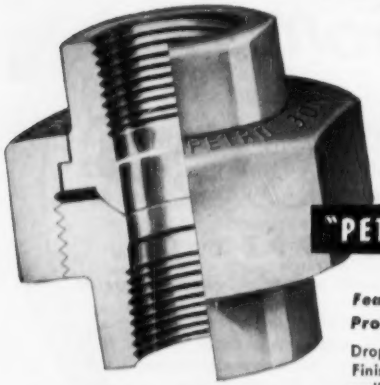
- Quiet, vibration-free operation
- 20 to 60% more valve area
- less power consumption
- minimum pressure loss
- normal discharge temperature
- lower operating costs
- utmost safety

Our detailed proposal for increasing the efficiency of your compressor will be sent you without obligation. Send us the name, bore, stroke, and speed of your machine.

J. H. H. VOSS VALVES
REG. U.S. PAT. OFF.

VOSS VALVES / J. H. H. VOSS Co., Inc. 785 East 144th Street, New York 54, N. Y.

again MARK is FIRST
with *America's Finest*
STAINLESS
STEEL UNIONS



"PETRO" 304-316

"PETRO" DUAL

These unions are made with stainless steel ends and carbon steel nuts. Nut threads are permanently lubricated for easy make and break.

Feature Packed for Multiple Service on All Processing Where Stainless Steel Is Required

Drop forged from uniformly heated solid bars. . . . Finished to American Standard A.A.R. . . . Uniform wall thickness and concentricity maintained through quality controlled production. . . . Precision machined seats plus a differential in hardness form a perfect seal and will not seize at high temperatures. . . . Octagon shaped ends and nut provide safety from and resistance to distortion by wrench abuse.

A NEW CATALOG COMPLETELY DESCRIBES ALL OUR UNIONS . . . WRITE TODAY!

Clayton Mark & Company
1900 DEMPSTER STREET EVANSTON, ILLINOIS U.S.A.

What's Happening. . .

M. W. Kellogg Company. During this period he was closely associated with the development of various petroleum-refining and chemical processes used today.

A new member of the Nofsinger company is Carl D. Spangler who has joined the Kansas City firm of engineers and constructors as a process engineer. He previously was a development and project engineer with Black, Sivalls & Bryson in Oklahoma City.

Charles Scrymgeour, formerly manager of the Imperial Oil Company, Ltd., refinery at Montreal East, has been transferred to the company's executive offices in Toronto, as management development counsellor. His reassignment was one of eight made as part of an over-all program to broaden managerial experience.

Named to replace Scrymgeour at Montreal was **J. L. Huggett.** Dr. Huggett was transferred from the company's Sarnia refinery, which he had headed since 1947. His Sarnia post was taken over by **George R. McMillin.**

H. H. Moor, who was superintendent of the Imperial refinery at Edmonton, has been made manager of the Halifax refinery. His Edmonton post has been filled by **E. Keith Lewis,** formerly superintendent of the Ioco refinery.

At Ioco, **A. G. Stewart** replaces Lewis, and **W. A. Murray** takes over as manager of the Winnipeg refinery, succeeding Stewart. Murray had been superintendent at Sarnia. He was replaced there by **W. R. Beynon,** who was assistant superintendent of the refinery.

P. N. Johnson has been named president of Salt Lake Refining Company. The company is a subsidiary of Standard Oil Company of California. Johnson, who has been on special assignment with Standard's Manufacturing department, takes over the presidency of the subsidiary from **J. T. Higgins,** who is being advanced to general manager of the Manufacturing department.

The new Salt Lake president has been with the Standard organization since 1939. Prior to his last assignment, he served as superintendent of the company's El Segundo, Calif., refinery.

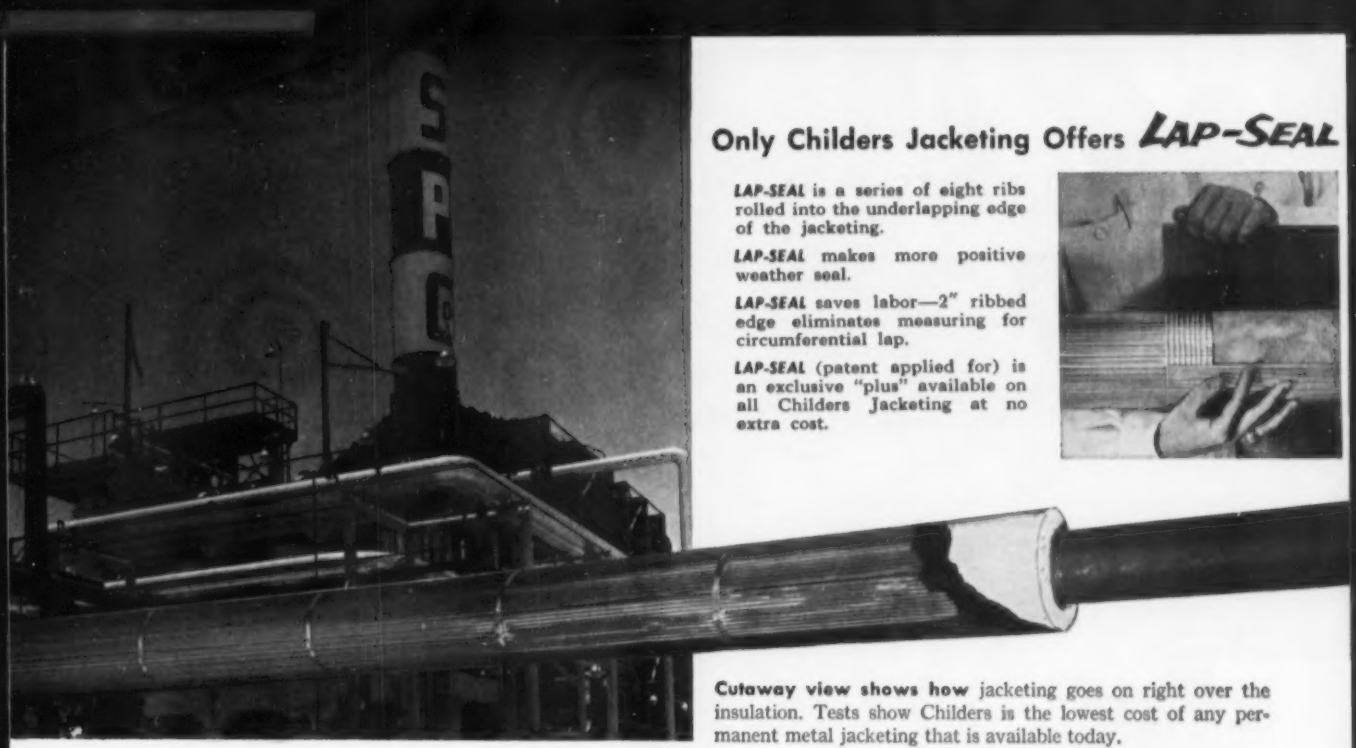
John E. Wood, assistant general manage of Esso Standard Oil Company's Chemical Products department, has been promoted to general manager of the department, succeeding O. V. Tracy. Tracy, who continues as a director of Esso and president of its subsidiary Enjay Company, will direct all the company's chemical operations.

Dr. Wood, who had been assistant manager of the department since September 1955, joined the company in 1939 at the Esso Research Laboratories in Linden, N.J. From 1941 until 1955, he served at the Baton Rouge, La., refinery. When transferred to the department's New York offices, he was head of the Chemical Products division at Baton Rouge.

Death:

S. D. Douglas, senior scientist in the Research department of Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation, died in Houston January 15, after a long illness.

For more data on advertised products, use Readers' Service Cards, last page.



Only Childers Jacketing Offers LAP-SEAL

LAP-SEAL is a series of eight ribs rolled into the underlapping edge of the jacketing.

LAP-SEAL makes more positive weather seal.

LAP-SEAL saves labor—2" ribbed edge eliminates measuring for circumferential lap.

LAP-SEAL (patent applied for) is an exclusive "plus" available on all Childers Jacketing at no extra cost.

Cutaway view shows how jacketing goes on right over the insulation. Tests show Childers is the lowest cost of any permanent metal jacketing that is available today.

Only pliers and pocket knife needed to apply easy-to-handle Childers Aluminum Jacketing

Best method of applying jacketing is with aluminum strapping and seals. Other method is to use sheet metal screws.

Aluminum strapping can be pulled tight enough with just pliers. Lugs are then bent over and fastening is complete.

Eastern States Petroleum's two-man crew covers insulated lines, even L's and bends—using light-weight, weatherproof aluminum jacket.

Childers Jacketing for insulated lines, made of .006" 3S alloy aluminum, was used to cover thousands of feet of line in Eastern States Petroleum's Houston plant.

As it does in over 1000 other plants in all 48 states and many foreign countries, Childers Jacketing helped save Eastern States many expensive hours of application and maintenance time.

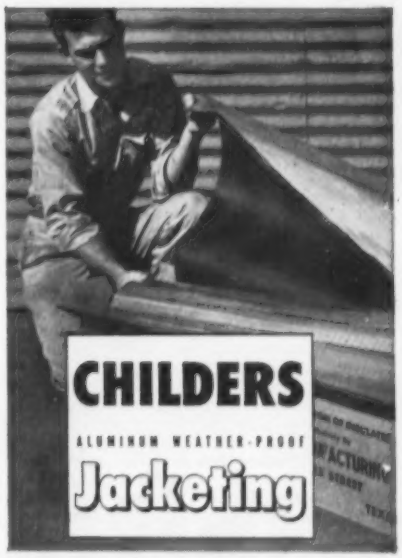
In fact, tests show this: Two men, working with Childers Jacketing for the first time, can cover more feet of insulated line in a day than with practically any other kind of covering. This means real savings in application costs.

The cost is low, too. You can actually put aluminum jacketing on your lines for less than the cost of the cheapest weatherproofing when one paint job is considered.

Immediate shipment from our large factory stocks can eliminate costly delays in construction or plant improvement schedules.

Try this low cost protection in your plant. Write today for engineering data and information about how you can order a 400 sq. ft. roll to test on one of your insulated lines. No obligation. Address: Childers Manufacturing Company, Department PR-31, 3620 West 11th Street, Houston, Texas.

Engineering representatives in most cities to work with you on jacketing problems.



Childers Jacketing arrives on the job in convenient rolls 4 feet wide and 100 feet long —easy for one man to handle. Jacketing comes with or without a moisture barrier attached to the back of the .006" aluminum. Rolls are well protected for field storage if kept dry. Boxes light enough for one man to carry. (Adv.)

What Suppliers Are Doing . . .

Cox Klopf Mrozek Banks Morris Briney Black Frees Foltz

Clifford N. Cox has been appointed sales manager for **Insul-Mastic Corporation's** line of protective coatings and insulation. Prior to joining Insul-Mastic, Cox was sales manager and Eastern division manager for D. A. Stuart Oil Company of Chicago. Previous association was with Archer-Daniels-Midland Company as manager, Specialties division.

Arthur S. Klopf has been appointed manager of marketing for **American Gilsonite Company.** Klopf will direct all sales and marketing activities of the company including products from their new gasoline refinery and metallurgical coking plant now being erected near Grand Junction, Col. He was formerly general sales manager of Missouri Coke and Chemical division of Great Lakes Carbon Corporation.

Elmer V. Mrozek has been named to represent the Hydreco and Dudco division of **The New York Air Brake Company** in the greater Chicago area. Mrozek comes to New York Air Brake from the Donnell Hydraulic Company of Marengo, Ill.

W. L. Banks has been named sales representative for the Petroleum Catalyst department of **Davison Chemical Company Division of W. R. Grace & Company,** in the area covered by the company's Houston office. Banks has been with the Central Intelligence Agency. He previously was with The Texas Company at its Port Arthur, Texas, refinery. He is a registered engineer in Texas and Ohio.

L. J. Morris has been appointed assistant district manager at Pittsburgh, succeeding **W. C. Robinson** for **Tube Turns.** Robinson was made an assistant sales manager, engaged in sales promotional programs in the company's Eastern division. Morris was process equipment buyer for the Fraser-Brace Engineering Company, before joining one of Tube Turns' affiliated companies in 1943. He became a member of the Pittsburgh sales staff in 1949.

William F. Briney has been appointed manager of construction industry sales for the Le Roi division of **Westinghouse Air Brake Company.** Briney, who started with the division in 1949 as a sales and service trainee, now is responsible for planning sales for Le Roi products used by the construction industry. Until recently he was sales manager for a large West Coast heavy-construction-machinery distributor.

Malcolm W. Black heads a firm of manufacturers' representatives, Malcolm W. Black, Inc., which have been appointed to represent **Chiksan Company** in southern New York and northern New Jersey. The Black organization is a New York City firm.

C. Norman Frees has been named sales representative in Mexico for **The Babcock & Wilcox Company's** Tubular Products division. Frees, for 11 years engaged in industrial sales in Mexico, will represent B&W throughout the republic.

Frederick F. Foltz has been appointed field erection manager for **Chicago Steel Tank Company.** The company is a division of U. S. Industries, Inc. He will be responsible for the supervision of crews erecting on-the-site storage tanks and other structures contracted by the Chicago firm. He has been engaged in engineering and construction work since 1946.

Oliver Lefebvre Oldshue Pierpont Gulley Weith

John K. Oliver has been made manager of **Wagner Electric Corporation's** Portland, Ore., Electrical division branch office. Oliver started with the company as a student engineer in 1948. Prior to his recent appointment, he was a sales engineer in the company's branch offices at Seattle and Portland.

Gordon Lefebvre, formerly president of Cooper-Bessemer Corporation, has joined **Clark Brothers Company,** a division of Dresser Industries, Inc. He has been general manager of General Motor's Pontiac division plant at Pontiac, Mich., general manager of the G. M. plant at Oshawa, Canada, and been in charge of all production, inspection and plant construction for the Chevrolet plant at Detroit.

James Y. Oldshue has been advanced to director of research with **Mixing Equipment Company, Inc.** Dr. Oldshue has been engaged in fundamental and applied research in fluid mixing since joining the company in 1950. Prior to his promotion, he served as head of development engineering.

Harlan T. Pierpont has been appointed sales manager for refractories in the new Abrasive division of **Norton Company.** In a move designed to consolidate each product line under a single head, Pierpont was designated to continue responsibility for the sale of all Norton refractory products. Pierpont began his selling career as an abrasive engineer in 1937 at St. Louis, and later he served the company in that capacity at Chicago and Flint, Mich.

William F. Gulley, Seattle district sales manager for **Rockwell Manufacturing Company's** Meter and Valve division, has been named San Francisco district manager. He is succeeded by **Roy E. Nimtz,** a sales engineer in the San Francisco district more than three years. Gulley joined Rockwell as a sales engineer in 1947; Nimtz was a technical assistant with Pacific Gas and Electric Company before joining Rockwell in 1952.

A. J. Weith has been promoted to sales manager of **American Cyanamid Company's** Petrochemicals department. Dr. Weith, who became assistant sales manager of Petrochemicals in 1954, joined Cyanamid in 1947 as a research chemist in the company's Stamford, Conn., research laboratories. In 1949, he was transferred to the Industrial Chemicals division and served in various capacities. He joined Petrochemicals in 1953.

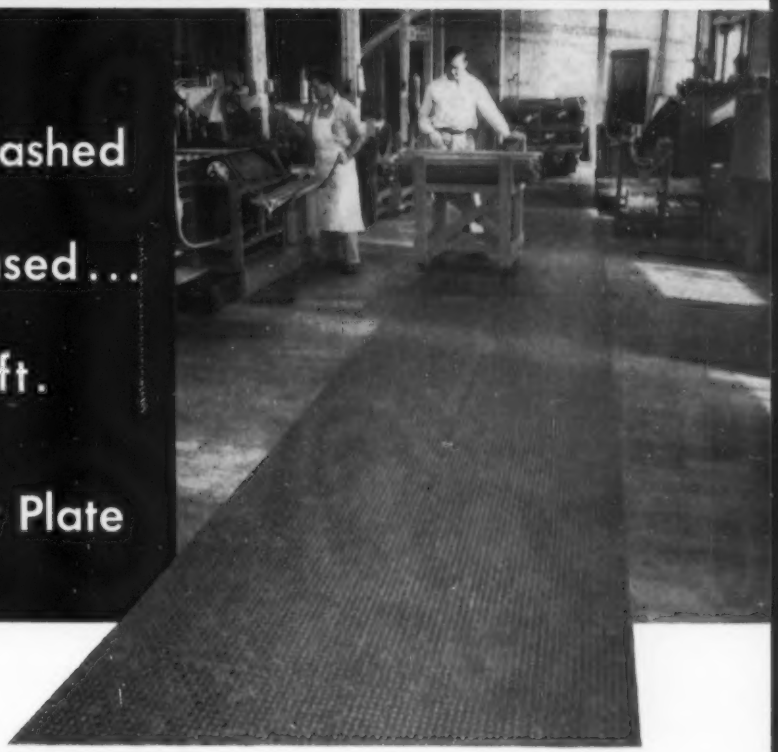
Nechemias Kelly McCartney

Herbert B. Nechemias has been made manager of the Cincinnati, Ohio, Electrical division branch office of **Wagner Electric Corporation.** Nechemias has been with Wagner since 1938 when he joined the company as a student engineer.

Paul E. Kelly has been appointed assistant manager of sales for the Alloy Tube division, **The Carpenter Steel Company.** He will be at the division's home office and mill in Union, N. J. Kelly has been eastern regional sales manager for the division since 1953.

Robert R. McCartney has been appointed vice president in charge of overseas operations for **Clark Bros.** Company, of the

Maintenance costs slashed ... safety hazards erased ... with 50,000 sq. ft. of *Multigrip* Floor Plate



THE STANLEY HOME PRODUCTS plant, East Hampton, Mass., is a busy place. Hour after hour hand trucks and fork lifts shuttle up and down the aisles carrying production materials and finished products. Heavy traffic like this subjects floors to tremendous wear. In fact, the old wooden aisles in the Stanley plant developed deep ruts, making it difficult to maneuver trucks. The ruts also created a safety hazard due to splintered wood and sprung nails. Repairs to the aisles were frequent . . . and expensive!

RUGGED AND SAFE

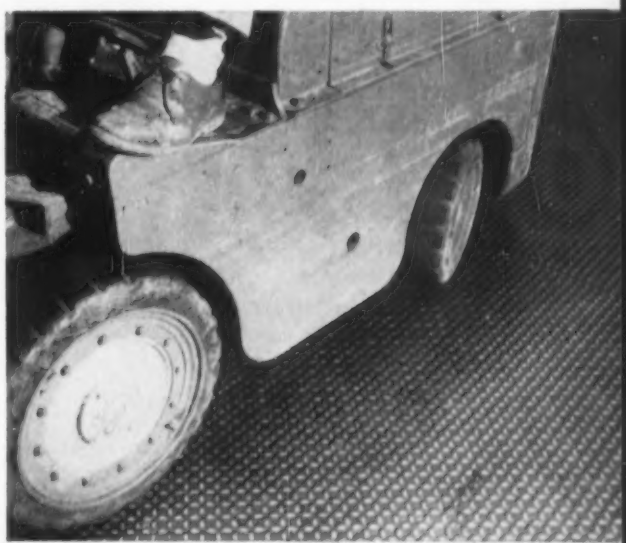
A floor covering was needed that was rugged enough to stand up under severe wear, wouldn't chip, crack or splinter and at the same time, offered positive traction to both feet and wheels. Many mattings were tested but only USS Multigrip Floor Plate met ALL of the requirements. Now, 50,000 square feet of Multigrip cover all aisles in the production area.

IDEAL FLOOR COVERING

Multigrip is made of rugged steel to resist wear, even under the most severe traffic conditions. Evenly-spaced, flat-topped risers give positive traction to busy feet and wheels. Because Multigrip can't soak up oil or grease, cleaning is no problem. A broom or hose is all that is needed . . . and Multigrip's special design allows drainage in *all* directions. Eliminate danger areas in your own plant by safe-treading with USS Multigrip Floor Plate. Installation is simplified because Multigrip is available in large plates and may be bent or formed where necessary. On aisles, ramps, loading platforms, stairs and entire floor areas, USS Multigrip Floor Plate is safe, practical and durable.

Flat-topped risers on Multigrip Floor Plate guarantee traction for wheels and feet, helping to eliminate slipping accidents in danger areas. It's ideal for use on stairs, aisles and platforms. This Stanley Home Products plant uses 50,000 square feet of Multigrip to protect aisles.

IN SERVICE SIX YEARS, this Multigrip shows practically no signs of wear. Stanley Home Products first used Multigrip in 1949. It stood up so well under terrific abuse that they have since covered ALL production aisles with Multigrip Floor Plate.



UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, CHICAGO
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS multigrip FLOOR PLATE

Sold by leading distributors from coast to coast

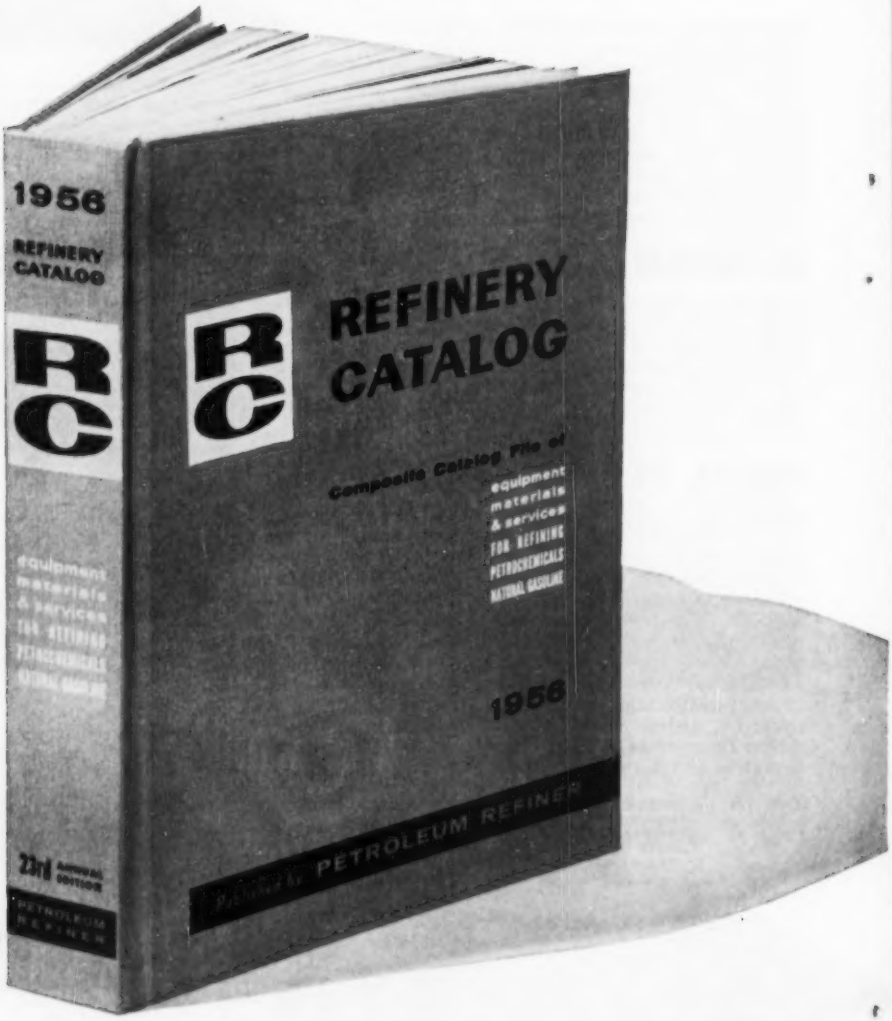
6-256

UNITED STATES STEEL

NOW

BETTER THAN EVER

Here's how the REFINERY CATALOG's 1956 Edition appears, with new cover design featuring a large "RC" for easy identification.



For more data on advertised products, use Readers' Service Cards, last page.

MOST COMPLETE SINGLE SOURCE

..... of Equipment-Service Data in

– Refining
– Natural Gasoline
– Petrochemicals

Completely indexed and cross indexed . . . Saves Time
Refer to it when ordering . . . specifying . . . inquiring

Make your buying job easier, eliminate errors, reach for your copy of The Refinery Catalog and watch for quick, efficient results.

More Complete and Useful Than Ever

The Refinery Catalog is an indispensable tool, more valuable and useful this year than ever before. Here's part of what you'll find in it!

★ Complete or condensed catalogs of more than 270 manufacturers, service companies, and suppliers serving the industry.
★ Authoritative, up-to-date specifications and data.
★ Local sources of supply.
★ Convenient alphabetical index of manufacturers and a classified index of equipment, materials and services.

If you are not among the thousands of men in buying power jobs whose names have been submitted to us by their companies to receive a personal copy of the current Refinery Catalog, tell your immediate supervisor that you'd like to be included. In the meantime, you're sure to find a copy you can use somewhere nearby in your department. Remember to look for the large "RC" on the cover.

The REFINERY CATALOG

Published Annually by PETROLEUM REFINER · Gulf Publishing Company

P. O. BOX 2608 • HOUSTON 1, TEXAS

Suppliers . . .

Dresser Industries. He will devote full time to the company's overseas operations, including registered foreign offices, manufacturers' agents and three licensed overseas manufacturers of Clark equipment. In 1937, McCartney joined Clark as a sales engineer. Subsequently, he held various management positions in the New York district. In 1953 he was appointed Eastern regional sales manager and director of export operations.

The Pfaudler Company has made **Ranlet Miner** its chairman of the board, and **Donald A. Gaudion**, executive vice president. Miner had been vice chairman of the Pfaudler board since 1951 and he now succeeds his father, **Edward G. Miner**, who died October 10, 1955. Gaudion had been a vice president of the company since 1952. He has also held the position of assistant to the president for six years.

Gustin-Bacon Manufacturing Company recently added three new men to its sales force.

- **J. A. Fairfield** will be assigned to the Chicago sales district. His territory will include eastern Wisconsin, northwest Illinois and northeast Iowa, formerly handled by **George K. Leisenring** who has resigned. Fairfield formerly was associated with Owens-Corning Fiberglas Corporation.
- **R. E. Van Winkle** will handle sales in Michigan, northern Indiana and northwestern Ohio, replacing **J. E. Rapp**, who has been transferred to the home office at Kansas City. **Van Winkle** formerly was associated with Alexander-Stafford Corporation at Grand Rapids.
- **C. Barry Neill, Jr.**, has been assigned to the Atlanta sales area. He will handle sales in Alabama, western Tennessee and western Georgia. Neill, who was with William Powell Company of Atlanta, replaces **Clark M. Page**, now Kansas City district sales manager for Gustin-Bacon.

Sinclair Chemicals, Inc., subsidiary of Sinclair Oil Corporation, has appointed **Anton M. Horehled** as manager of nitrogen product sales to direct Sinclair's sales of anhydrous ammonia and nitrogen solutions from the Calumet nitrogen products plant at Hammon, Indiana. In 1948 he was employed with the Sales department of Wisconsin Farmco Service as representative at Kaukauna, Wisconsin. From 1951 to 1953, Horehled was employed in the Nitrogen Division, Wholesale Sales department of Olin Mathieson Corporation in the Midwestern area.

Horehled

Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation has appointed two new district managers. **W. M. Anderson** has been appointed district manager of the New York district. He had been district manager of the Cleveland district. **J. K. Marshall** has been appointed district manager of the Cleveland district. He had been acting district manager of the New York district.

Peerless Pump People Parley—

All district sales managers and certain engineering, manufacturing and administrative personnel of Peerless Pump Division, Food Machinery and Chemical Corporation met recently in Los Angeles. Personnel that attended the meeting:

First row (left to right): C. H. Sortor, Fresno; C. C. Cook, Atlanta; W. J. Blair, Los Angeles; G. D. Sickert, Indianapolis; B. A. Tucker, Los Angeles; J. F. Van Dam, Los Angeles; R. P. Young, New York; C. L. Nickel, Indianapolis; W. T. Harman, Indianapolis; E. W. Lundy, Los Angeles; S. M. Riordan, Jr., Los Angeles.

Back row (left to right): J. B. Downie, Los Angeles; R. G. Trout, Los Angeles; V. L. Ray, Los Angeles; R. F. Foster, Los Angeles; R. E. Kummer, Indianapolis; F. D. Widener, Los Angeles; G. F. Twist, Los Angeles; E. H. Hansen, Fresno; J. C. Bonsall, Los Angeles; W. E. Griffin, Lubbock; F. G. Riddle, Los Angeles; N. C. Olson, Indianapolis; R. H. Hull, Los Angeles; D. R. Rankin, Los Angeles.

Diamond Alkali Company has named **Thomas E. Kuby** as assistant manager of public relations and advertising. Kuby's primary responsibilities will be editing a bi-monthly employee-stockholder magazine, and he also will take part in formulating and administering the company's public relations, advertising and sales promotion activities.

U. S. Steel Corporation has appointed **Scott T. Lutz** as manager of the Kansas district of its Oil Well Supply Division. He will headquarter at Wichita, Kansas.

Lutz joined Oilwell in 1937 at Hutchison, Kansas, and later served at Wichita, McPherson and Stafford, Kansas. He was city representative at Wichita, prior to his present appointment.

General Precision Equipment Corporation has reached an agreement for the acquisition of a majority of the outstanding stock of Shand and Jurs Company.

Pioneer in the development of equipment related to the safe storage and transportation of volatile liquids, Shand and Jurs was organized originally in 1922. Today the company is a recognized leader in the design, manufacture and sale of fittings and accessories for the handling, storage, measurement, conservation and transportation of flammable or explosive liquids, ashore and afloat.

Olin Mathieson Chemical Corporation has named **Frank A. Gerard** as safety manager. He has been supervisor of employee services at the East Alton plants, and will be located in the company's New York offices. Gerard has spent most of his career in safety promotion work. He was first with U. S. Steel Corporation as assistant safety engineer at their Duluth, Minn. plant. He has held other safety positions with Du Pont, Briggs Body Corporation, Square D. Switch Company, and the State of Minnesota. He joined Olin Industries, Inc. in 1942.

Minneapolis-Honeywell Regulator Company has added 21 new sales engineers to the field sales force of its Industrial division. They were assigned to 19 branch offices located in 18 U. S. cities and one Canadian city.

The new appointees include: William Bater and Robert W. O'Reilly, Philadelphia; David B. Beasley, Toronto; Walter E. Biewer and Robert E. Day, Los Angeles; Robert J. Byers, Milwaukee; A. P. Ciprari, International Division, New York; Alan L. Colter, Buffalo; John L. Dyer, Cincinnati; Merton H. Fischer, International Division, Minneapolis; Michael N. Francher, Syracuse, and Eugene D. Haugen, Seattle.

Also, Charles C. Hulsey, Columbia; Charles B. MacRae, Houston; Robert J. Owen, Cleveland; John B. Prouty, Columbus; Harvey F. Renee, Indianapolis; Bertram R. Robinson, Union; Russell W. Skinner, Pittsburgh; Jack D. Stickley, Oklahoma City, and Richard E. Swenson, Twin City.

Hercules Powder Company has made **Donald H. Sheffield** assistant general manager of its Synthetics department. At the same time, the company announced that **R. Stanley George** has been named manager of the Oxychemicals division of Hercules' Naval Stores department, succeeding Sheffield; **Paul L. Johnstone** was named director of development for the company's Cellulose Products department; **Harvey J. Taufen** was named director of development for the Synthetics department, succeeding Johnstone, and **C. D. Ender** was named to succeed **George** as director of development for Naval Stores.

American Cyanamid Company has promoted **A. J. Weith** to sales manager of its Petrochemicals department. He will remain located in the general offices at New York. Dr. Weith, who became assistant sales manager of Petrochemicals in 1954, joined Cyanamid in 1947 as a research chemist in the company's Stamford, Conn.

you can meet your needs

exactly

Ethylene Glycols

Ethanolamines

For Gas Purification—Mono- and diethanolamine of uniform purity for H_2S and CO_2 scrubbing. Mathieson production consistently meets standard specifications.

For Gas Dehydration—Di- and triethylene glycol with the most important specification: "convenient availability." Stocks of Mathieson products are located to give prompt service in all important refining areas.

For Selective Extraction—Diethylene glycol with highest purity specifications is the answer. Olin Mathieson can supply to meet your most exacting requirements.

For Other Uses—You need a variety of chemicals. You can satisfy many of your requirements from Mathieson's wide line of ethylene oxide derivatives.

Ask us to meet your particular need exactly. Write or call.

MATHIESON CHEMICALS
OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION · BALTIMORE 3, MD.

3624

INORGANIC CHEMICALS: Ammonia · Bicarbonate of Soda · Carbon Dioxide · Caustic Soda · Chlorine · Caustic Potash · Hydrazine and Derivatives Hypochlorite Products · Nitrate of Soda · Nitric Acid · Soda Ash · Sodium Chlorite Products · Sulphate of Alumina · Sulphur (Processed) · Sulphuric Acid

ORGANIC CHEMICALS: Ethylene Oxide · Ethylene Glycols · Polyethylene Glycols · Glycol Ether Solvents · Ethylene Dichloride · Dichloroethylether Formaldehyde · Methanol · Sodium Methylate · Hexamine · Ethylene Diamine · Polyamines · Ethanolamines · Trichlorophenol · Trichlorobenzene

Step UP

with

Gardsman

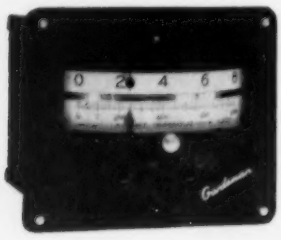
MODEL

JP SERIES

PROPORTIONING

TEMPERATURE

CONTROLLER



CONSISTENT ACCURACY!

This *tube-free* instrument brings many advantages over *any* on-off controller. *Anticipates* temperature change, tends to stabilize at *closer* tolerance. Cuts rejects, maintenance; ends adjustment, tube-replacement. Reliability *Guaranteed.* Write for Bulletin JP-1.

4357B West Montrose Ave.
Chicago 41, Illinois

WEST *Instrument*
CORPORATION
CHICAGO
SALES OFFICES IN PRINCIPAL CITIES

"How To Get Those Top Octanes"

Now available in reprint form, this article by Marshall Sittig and Wayne Warren of the Ethyl Corp., appeared in the September, 1955, Process Issue of PETROLEUM REFINER.

Presented is a thorough treatment of octane improvement techniques, plus a most authoritative and up to date comparison of catalytic reforming processes. Here is a comprehensive, 50-page monograph that should be in every process man's reference file.

Available for only $1.00 per copy, this reprint can be obtained by addressing:

REPRINT DEPARTMENT

PETROLEUM REFINER

P. O. BOX 2608, HOUSTON 1, TEXAS

Suppliers . . .

research laboratories. In 1949, he was transferred to the Industrial Chemicals Division and served in various capacities. He joined Petrochemicals in 1953.

Bendix Aviation Corporation has established a new market research and development department directed by **Crockett A. Harrison.** Harrison, who joined the administrative staff of the corporation last year, also will be responsible for evaluating new products developed by other companies and offered to Bendix for further research in manufacturing and marketing.

Gayle

Phillips

Delta Tank Manufacturing Company has elected as its new president **Kenneth H. Gayle, Jr.,** former president of Ingalls Iron Works Company of Birmingham, Ala. **Hal S. Phillips,** president of Delta since 1946, has been elected chairman of the board of the Baton Rouge firm, a wholly-owned subsidiary of General Gas Corporation. He will continue to serve as treasurer of General Gas.

Gayle served as president of Ingalls Iron Works Company from 1951 through September, 1955. He joined Ingalls' Engineering and Sales department in Birmingham in 1923 after a year with the American Bridge Company of Penncoyd, Pa.

Atlas Powder Company has acquired Aquaness Corporation. Aquaness will function as a department of Atlas' Chemicals division. **Fritz E. Fuchs,** who served as vice president and general manager of Aquaness Corporation, will be manager of the new Aquaness department.

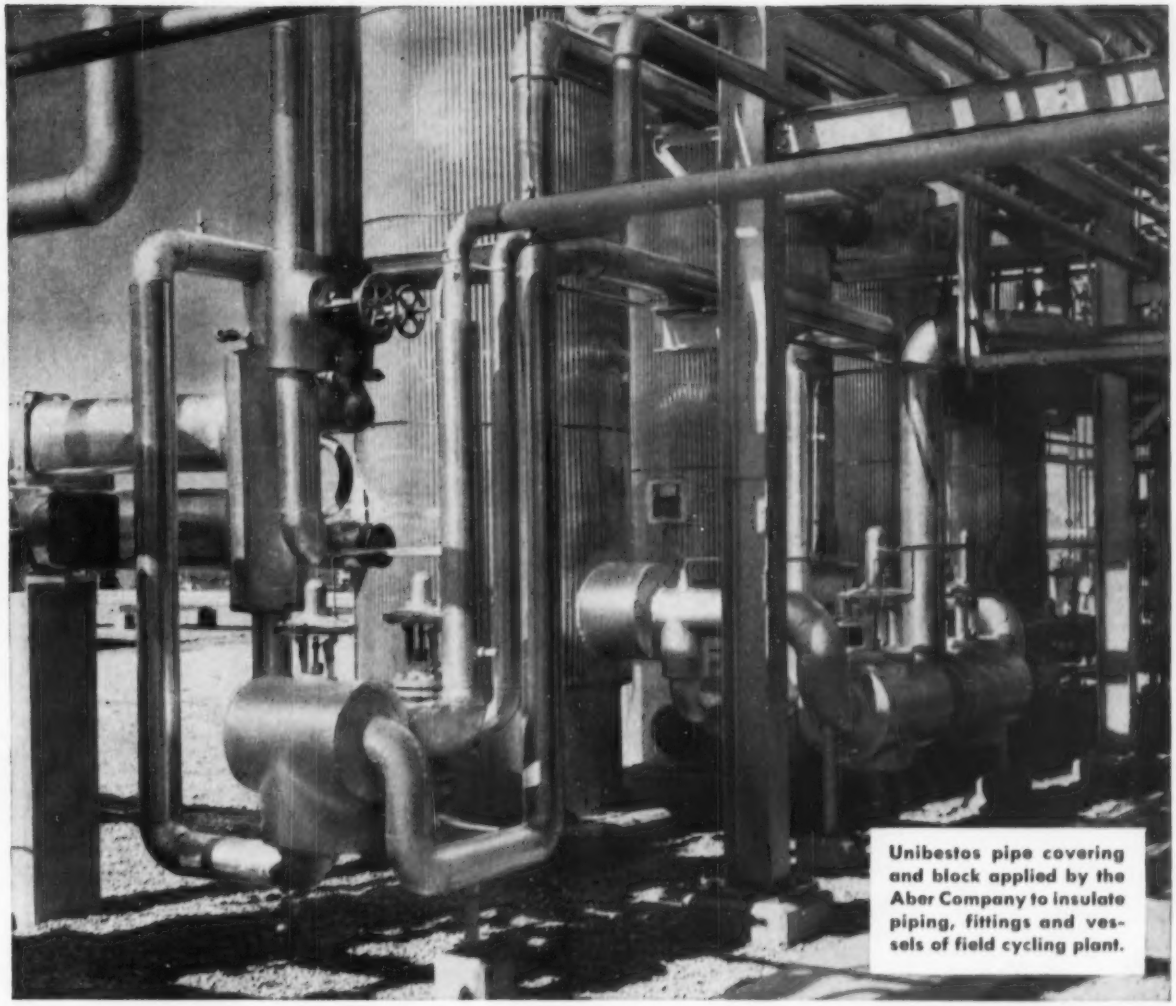
The Aquaness plant in Houston contains oxidation, oxyalkylation and esterification units, amine and amine salt reactors and blending equipment. It serves petroleum operations along the Gulf Coast and in West Texas, Kansas, Arkansas and Louisiana, as well as in foreign countries.

General Controls Company has pro- promoted **George A. Williams, Jr.,** to the position of manager of its Detroit factory branch. Williams has been assistant manager of the Detroit branch, one of the 40 General Controls' factory branch offices throughout the U. S. and Canada.

The A. Y. McDonald Manufacturing Company celebrates its centennial anniversary this year. The company was founded in Dubuque, Iowa by A. Y. McDonald in 1856. From a modest machine shop turning out hand pumps, the manufacturing facilities have grown to a plant that covers five-and-a-half acres of ground and employs 510 people.

Koch Engineering Company, has appointed Jacobs Engineering Company, Pasadena, Calif., its representative for that

For more data on advertised products, use Readers' Service Cards, last page.



Unibestos pipe covering and block applied by the Aber Company to insulate piping, fittings and vessels of field cycling plant.

Unibestos makes hardest joints seem easy

Nothing is tougher to insulate than fittings. Yet whole networks of tees, ells, expansion joints and other fittings are required for today's refining process. Protecting these systems really tests the efficiency of any pipe insulation. And when it comes to cutting heat loss to a minimum, more and more refineries are relying on *single-layer* Unibestos®.

Unibestos gets its superior insulating properties from Amosite. This quality asbestos has long interlacing fibers that form positive heat seals at the joints—to provide protection without additional calkings.

And Unibestos has the strength to withstand shock...the stability to resist moisture, acid or chemical fumes. Easy to cut, miter or groove, single-layer Unibestos can be installed faster with virtually no cleanup. Unibestos pipe insulation is available in sectional form through 44" O.D.

Joe Bestos says:

Only single-layer Unibestos is so simple to install on fittings. It cuts and handles easily without breaking.

Write for **FREE** descriptive Bulletin 109C.

UNARCO

UNION ASBESTOS & RUBBER COMPANY

1111 West Perry Street • Bloomington, Illinois

For more data on advertised products, use Readers' Service Cards, last page.

Headquarters
for
PETROLEUM
TESTING
EQUIPMENT
used by...
• Refineries
• Gasoline Plants
• Petrochemical Plants
W. H. CURTIN & CO.
DOMESTIC EXPORT
LABORATORY APPARATUS & CHEMICALS
HOUSTON • NEW ORLEANS
TULSA • BIRMINGHAM • UTA.

ERNST
Boiler Accessories
Fig. 4
Inclined Water Gage
Fig. 10
Plain Sight
Illuminator
Fig. 31
Guard
Fig. 15
DCP weighted
try cock
Fig. 5
Standard vertical bronze
water gage, 350 pound
Send for Catalog
ERNST WATER COLUMN & GAGE CO.
Livingston, N. J.

Suppliers . . .

area. Jacobs Engineering, headed by **Joe Jacobs**, president, has handled items for the oil and chemical industries since 1947, and has a long history of successful representation in the west coast area. The Jacobs company also has a branch at Oakland, Calif., headed by **Thomas B. Dorris**. The Oakland office serves the northern part of the state.

The Sealol Corporation has announced the appointment of **Evan L. Price** as New York representative for the Sealol line of shaft seals. Price will cover New York City, Long Island, southeastern New York and northern New Jersey. He was previously with Johnston & Jennings Company.

Taylor Instrument Companies has appointed **George E. Heller** to assistant industrial sales manager. In his new capacity, Heller will work closely with the field organization and also concern himself with the introduction of new product.

Heller

Heller joined the firm in 1934 promoting the sale of the company's industrial products in the textile industry. In 1938 he transferred to the Application Engineering department and was assigned to instrument problems in the dairy, textile and chemical industries. Since 1951 he has been a divisional sales manager in chemical and petroleum sales.

Yale & Towne Manufacturing Company has appointed **Paul R. Minich, Jr.**, formerly a Yale representative, to general sales manager of the Materials Handling division. **Joseph J. Murray**, veteran Yale sales department executive, has been named to a newly-created post of assistant general sales manager.

In the post of sales manager, Minich heads an industrial lift truck sales organization which includes eight branch sales and service offices, 74 independent representative sales and service offices and five special railroad representative offices throughout the U. S., Canada and Hawaii.

General Controls Company has appointed **John F. Dickson** as manager of its Chattanooga, Tenn. branch office. Dickson formerly was a field representative at the General Controls Detroit factory branch, one of the firm's 40 branch offices.

Alan Wood Steel Company has elected **Chester E. Davis**, executive vice president of the company, a member of the board of directors. Davis succeeds the late **Alan Wood, III**, who died recently.

Davis has been associated with Alan Wood Steel for the past 25 years. He came to the company as industrial engineer in 1930 from the Central Alloy division of Republic Steel Corporation. In 1937 he was named assistant to the vice president; was elected vice president in 1939 and executive vice president in 1943.

Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation, has made several changes in its Research department. **W. N. Stoops** has been appointed associate director. **H. C. Chitwood, B. J. Cottrell, Benjamin Phillips, G. M. Powell** and **A. T. Walter** have been appointed assistant directors. D. M. Young has been appointed assistant to the director of the research department and will be located in the New York office of the company.

Jefferson Chemical Company, Inc., has appointed **L. F. Dowding** as assistant general manager, Manufacturing division. He will make his headquarters in Houston.

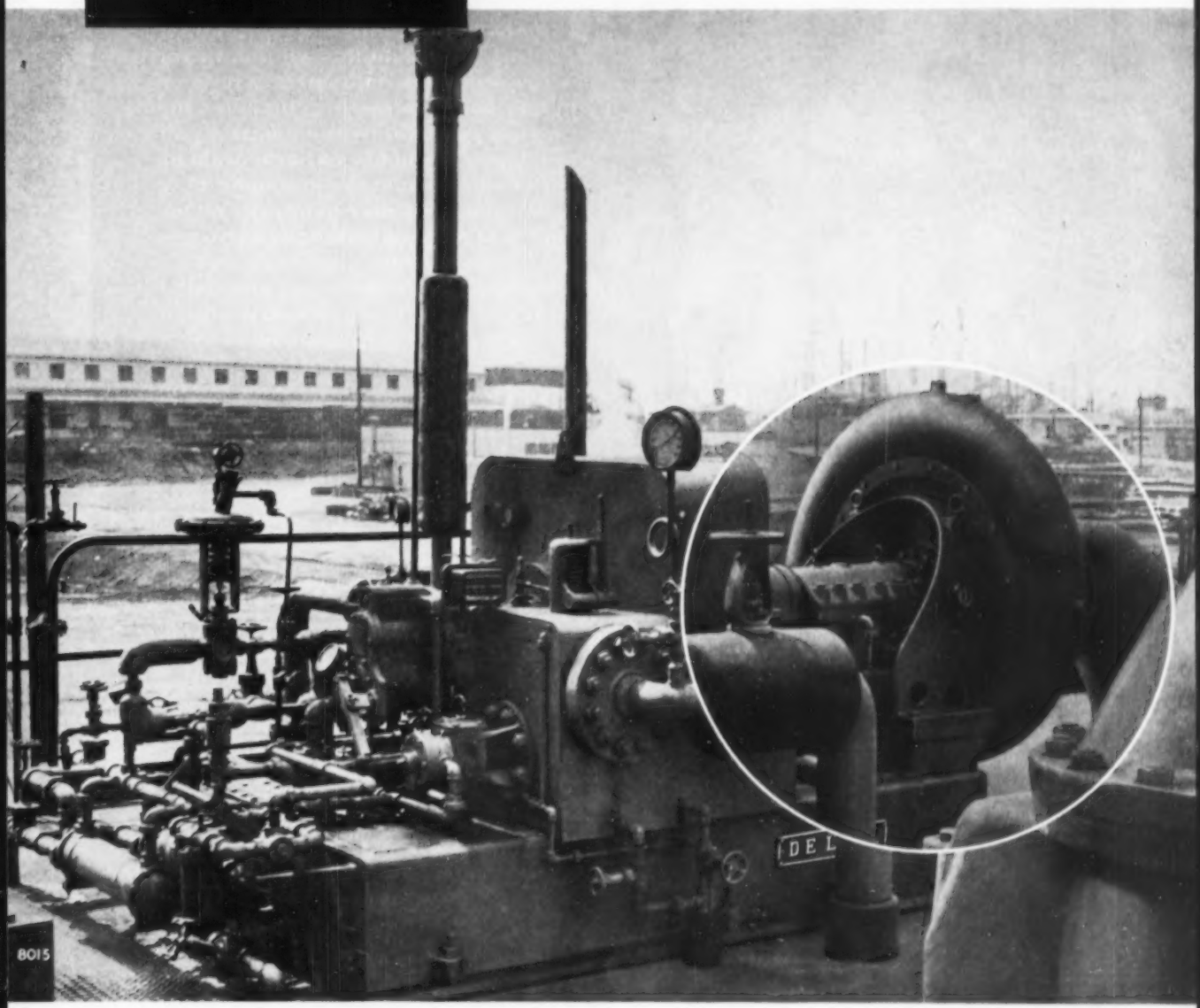
He joined the New York office of The Texas Company in 1939, remaining with them until 1949, and attaining the position of senior engineer when he transferred to

SPECTACLE BLINDS
By MAC-IRON
Skillfully machined from mild carbon steel, fire box quality, chrome-nickel, and other alloys.
SANDUSKY MAC-IRON OHIO
Estab. 1901
MAC-IRON Blinds, Spectacle Blinds, and Spacer Rings are available in all pipe sizes and pressure ratings for use with flat, raised face, and ring joint types of flanges. Precision machined from the particular metal needed, they can be supplied, if desired, with phonographic serrated surfaces.
MAC-IRON also offers a complete listing of line and temporary strainers. The latter of woven wire, perforated basket and conical . . . all for use with raised face, and ring joint flanges. A large stock on hand is maintained; special strainers made to specification.
Accuracy of design and construction is assurance of dependable service from all MAC-IRON products.
WRITE DIRECT FOR COMPLETE INFORMATION
The Mack Iron Works Company
Warren and Water Sts. Sandusky, O.

BARRETT automatic
Filling and Crimping Equipment
for handling greases and other viscous fluids.
• No operator required.
• 100% air operated.
Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.
BARRETT
Manufacturing Co.
P. O. Box 8096, Houston 4, Texas
4330

DE LAVAL CENTRIFUGAL BLOWER

controls air in cat cracker at Standard Oil of California



This De Laval centrifugal blower, selected by the Fluor Corporation, is on stream at the Standard Oil Company of California's new cat cracker in El Segundo. For control air service, this blower delivers 9,500 cfm; inlet pressure is 15.4 psig and discharge pressure 19.4 psig. The blower is driven by a De Laval 220 brake horsepower MCP Turbine operating at 800 psig with a temperature of 650 F; it has all labyrinth shaft packing for high back pressure service.

In addition to single stage designs, De Laval makes a complete line of equipment for all refinery services, including multi-stage compressors driven by De Laval multi-stage turbines for condensing, non-condensing and automatic extraction applications.

Send for new Bulletin 0504

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY

811 Nottingham Way, Trenton 2, New Jersey

Headquarters
for
PETROLEUM
TESTING
EQUIPMENT
used by...
• Refineries
• Gasoline Plants
• Petrochemical Plants
W. H. CURTIN & CO.
DOMESTIC EXPORT
LABORATORY APPARATUS & CHEMICALS
HOUSTON · NEW ORLEANS
TULSA · BIRMINGHAM · U.S.A.

ERNST
Boiler Accessories

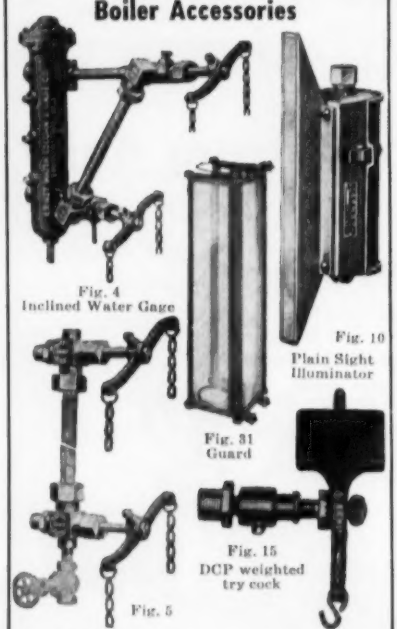



Fig. 4 Inclined Water Gage
Fig. 10 Plain Sight Illuminator
Fig. 31 Guard
Fig. 15 DCP weighted try cock
Fig. 5
Standard vertical bronze water gage, 350 pound
Send for Catalog
ERNST WATER COLUMN & GAGE CO.
Livingston, N. J.

Suppliers . . .

area. Jacobs Engineering, headed by **Joe Jacobs**, president, has handled items for the oil and chemical industries since 1947, and has a long history of successful representation in the west coast area. The Jacobs company also has a branch at Oakland, Calif., headed by **Thomas B. Dorris**. The Oakland office serves the northern part of the state.

The Sealol Corporation has announced the appointment of **Evan L. Price** as New York representative for the Sealol line of shaft seals. Price will cover New York City, Long Island, southeastern New York and northern New Jersey. He was previously with Johnston & Jennings Company.

Taylor Instrument Companies has appointed **George E. Heller** to assistant industrial sales manager. In his new capacity, Heller will work closely with the field organization and also concern himself with the introduction of new product.

Heller

Heller joined the firm in 1934 promoting the sale of the company's industrial products in the textile industry. In 1938 he transferred to the Application Engineering department and was assigned to instrument problems in the dairy, textile and chemical industries. Since 1951 he has been a divisional sales manager in chemical and petroleum sales.

Yale & Towne Manufacturing Company has appointed **Paul R. Minich, Jr.**, formerly a Yale representative, to general sales manager of the Materials Handling division. **Joseph J. Murray**, veteran Yale sales department executive, has been named to a newly-created post of assistant general sales manager.

In the post of sales manager, Minich heads an industrial lift truck sales organization which includes eight branch sales and service offices, 74 independent representative sales and service offices and five special railroad representative offices throughout the U. S., Canada and Hawaii.

General Controls Company has appointed **John F. Dickson** as manager of its Chattanooga, Tenn. branch office. Dickson formerly was a field representative at the General Controls Detroit factory branch, one of the firm's 40 branch offices.

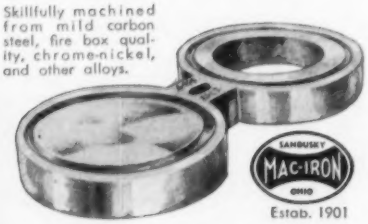
Alan Wood Steel Company has elected **Chester E. Davis**, executive vice president of the company, a member of the board of directors. Davis succeeds the late **Alan Wood, III**, who died recently.

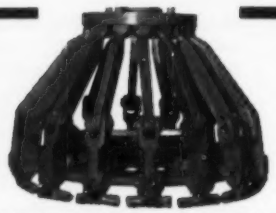
Davis has been associated with Alan Wood Steel for the past 25 years. He came to the company as industrial engineer in 1930 from the Central Alloy division of Republic Steel Corporation. In 1937 he was named assistant to the vice president; was elected vice president in 1939 and executive vice president in 1943.

Carbide and Carbon Chemicals Company a Division of Union Carbide and Carbon Corporation, has made several changes in its Research department. **W. N. Stoops** has been appointed associate director. **H. C. Chitwood, B. J. Cottrell, Benjamin Phillips, G. M. Powell** and **A. T. Walter** have been appointed assistant directors. D. M. Young has been appointed assistant to the director of the research department and will be located in the New York office of the company.

Jefferson Chemical Company, Inc., has appointed **L. F. Dowding** as assistant general manager, Manufacturing division. He will make his headquarters in Houston.

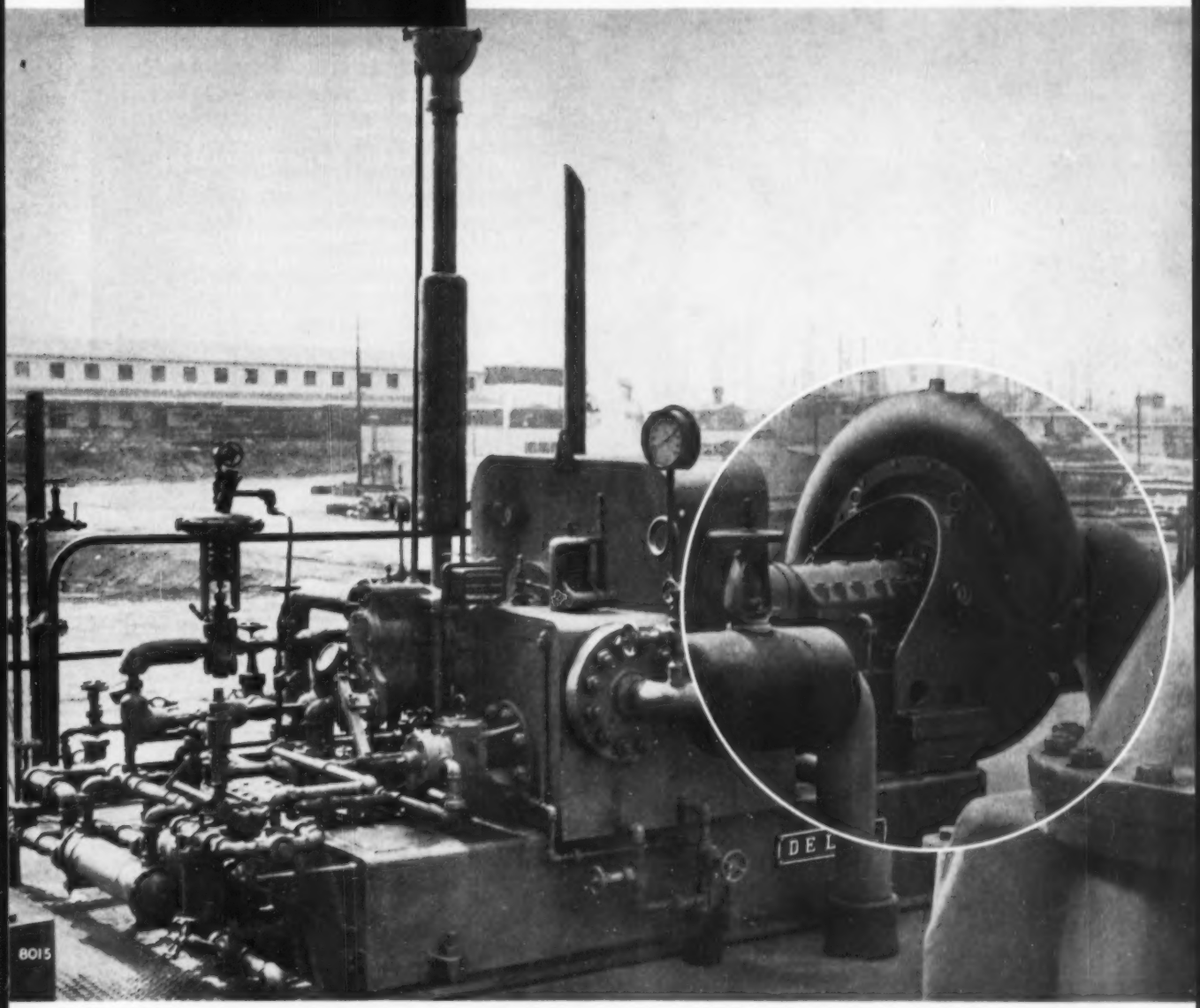
He joined the New York office of The Texas Company in 1939, remaining with them until 1949, and attaining the position of senior engineer when he transferred to

SPECTACLE BLINDS
By MAC-IRON
Skillfully machined from mild carbon steel, fire box quality, chrome-nickel, and other alloys.

SANDUSKY MAC-IRON OHIO
Estab. 1901
MAC-IRON Blinds, Spectacle Blinds, and Spacer Rings are available in all pipe sizes and pressure ratings for use with flat, raised face, and ring joint types of flanges. Precision machined from the particular metal needed, they can be supplied, if desired, with phonographic serrated surfaces.
MAC-IRON also offers a complete listing of line and temporary strainers. The latter of woven wire, perforated basket and conical . . . all for use with raised face, and ring joint flanges. A large stock on hand is maintained; special strainers made to specification.
Accuracy of design and construction is assurance of dependable service from all MAC-IRON products.
WRITE DIRECT FOR COMPLETE INFORMATION
The Mack Iron Works Company
Warren and Water Sts. Sandusky, O.


BARRETT automatic
Filling and Crimping Equipment
for handling greases and other viscous fluids.
• No operator required.
• 100% air operated.
Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.
BARRETT
Manufacturing Co.
P. O. Box 8096, Houston 4, Texas
4350

DE LAVAL
CENTRIFUGAL BLOWER

controls air in cat cracker at Standard Oil of California



This De Laval centrifugal blower, selected by the Fluor Corporation, is on stream at the Standard Oil Company of California's new cat cracker in El Segundo. For control air service, this blower delivers 9,500 cfm; inlet pressure is 15.4 psig and discharge pressure 19.4 psig. The blower is driven by a De Laval 220 brake horsepower MCP Turbine operating at 300 psig with a temperature of 650 F; it has all labyrinth shaft packing for high back pressure service.

In addition to single stage designs, De Laval makes a complete line of equipment for all refinery services, including multi-stage compressors driven by De Laval multi-stage turbines for condensing, non-condensing and automatic extraction applications.

Send for new Bulletin 0504

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey

Every week Harshaw produces carloads of catalysts, and every week we produce orders of only a few pounds for customers' experimental purposes. Whether your catalyst requirement is measured in tons or pounds, we have modern facilities for giving you exactly the catalyst you want. If you are in the experimental or development stage and need only a few pounds of your catalyst, call for our technical assistance; if you are in the production stage, call on Harshaw to produce any amount of catalyst you need. Our ability to produce will provide the catalyst...when you want it. If your mind's on catalysts, call Harshaw today.

HARSHAW produces carloads of catalysts *every week*

HARSHAW

Write for our free booklet, "Harshaw Catalysts"

HARSHAW CATALYSTS AVAILABLE IN 7 FORMS

- Tablets
- Powders
- Granules
- Extrusions
- Spheres
- Rings
- Flakes

THE HARSHAW CHEMICAL CO.

1945 East 97th Street, Cleveland 6, Ohio

Chicago 32, Ill.
Cincinnati 13, Ohio
Cleveland 6, Ohio
Detroit 28, Mich.
Houston 11, Texas
Los Angeles 22, Calif.
New York 17, N. Y.
Philadelphia 48, Pa.
Pittsburgh 22, Pa.

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

the Jefferson Chemical Company, Inc. Dowding started with Jefferson Chemical Company in the Engineering department, New York office. In 1954, he was transferred from New York to the Austin laboratories as assistant director.

General Controls Company has named **R. C. Servat** as manager of its Houston, Texas, branch. Servat formerly was manager of the General Controls New Orleans branch before assignment to Houston.

Sinclair Chemicals, Inc., subsidiary of Sinclair Oil Corporation, has appointed **John A. Corrigan** as district sales manager. Corrigan, who had previously been Sinclair Chemicals sales representative in Chicago, will manage the company's chemical marketing activities in the Midwest with headquarters in Chicago.

Corrigan

In 1949 he was employed with the U. S. Gypsum Company as sales engineer in Chicago, and later, in New Orleans. In 1951 Corrigan became sales supervisor for the Pennsylvania Salt Manufacturing Company in Tacoma, Wash. Prior to coming with Sinclair Chemicals in 1953, Mr. Corrigan was industrial sales engineer for The Pure Oil Company in Chicago and Minneapolis.

General Precision Equipment Corporation has arranged to acquire a majority interest in Shand & Jurs Company, a Berkeley, Calif., firm which makes equipment for storing and shipping flammable liquids.

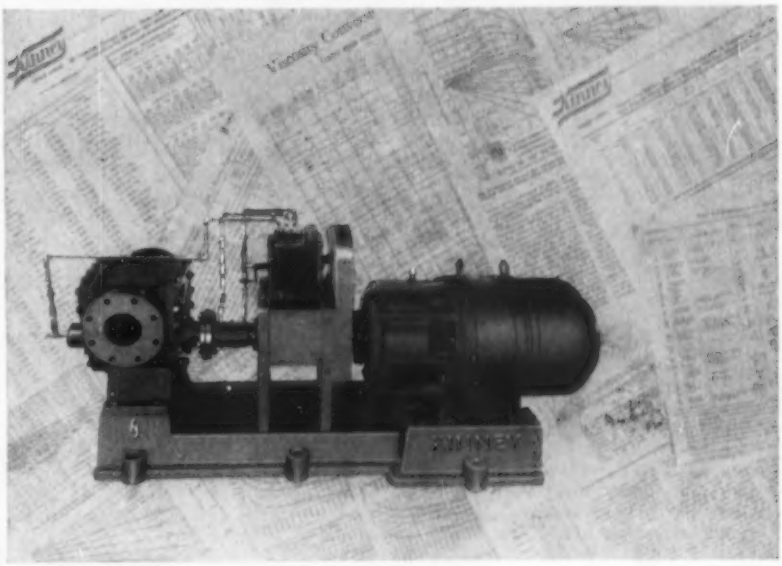
Rhodia, Inc., has appointed **Frank J. Milo** as sales representative, specializing in the sale of aromatic and industrial odor control chemicals. In 1946, he became associated with Givaudan-Delawanna, Inc., in technical sales. In 1948, upon the formation of the Sindar Corporation division of Givaudan, Milo was appointed assistant to the sales manager and handled all industrial aromatic chemicals and compounds. He spent five years in calls on potential customers and in development work; as well as actual liaison work between the various laboratories. From 1953, until he joined Rhodia, Mr. Milo was associated with Corona Mills.

Milo

Stauffer Chemical Company has made **Edward Beattie** its Chicago district sales manager. He will report to **Harold J. Klee,** Stauffer's Central division sales manager at Chicago.

General Electric has made three new appointments in its Construction Materials division. **William J. Donlin, III, Robert W.**

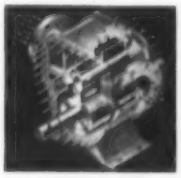
PERFORMANCE PROVES THE PUMP

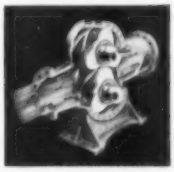


KINNEY PUMPS ARE PERFORMANCE-PROVED!

Performance proves the pump . . . and the outstanding performance reports on the famous Kinney Rotating Plunger Pumps and the Kinney Heliquad Rotary Pumps are proof of superior designing. Many exclusive features contribute to the long life and high efficiency of these pumps . . . and to their application flexibility. Oversized suction and discharge openings . . . larger shafts, and bearings . . . conservative capacity ratings . . . external anti-friction thrust bearings, etc. . . . are all contributing factors.

MODEL SD ROTATING PLUNGER PUMP for viscous fluids (asphalts, heavy oils, grease, emulsions, acid sludge, etc.) . . . can be used to meter or proportion fluid pumped. No valves, blades, springs, or vanes. Models range from 1½ GPM to 500 GPM, working pressures from 70 to 250 psi.





MODEL HQ HELIQUAD ROTARY PUMP . . . unique helical rotors assure continuous, non-pulsating fluid delivery over wide viscosity range (from gasolines or solvents to heavy oils or residuals). Bearings and timing gears external to pumping chamber. Capacities up to 2500 GPM; pressures up to 300 psi.

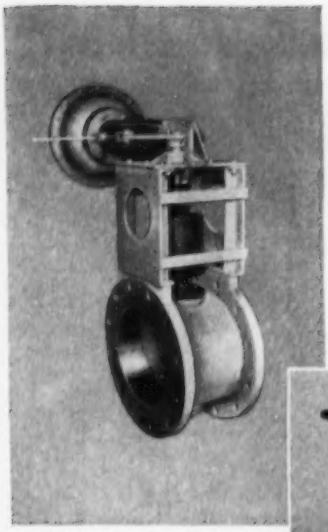
Send coupon today for complete pump data or contact the district office nearest you . . . in Boston, New York, Philadelphia, Cleveland, St. Louis, Chicago, Charleston (W. Va.), Detroit, Houston, New Orleans, Pittsburgh, San Francisco, or Los Angeles.

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3596 WASHINGTON STREET • BOSTON 30 • MASS.
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N.Y.

Please send Bulletin L51 describing the complete line of Kinney Liquid Pumps to:

Name.....
Company.....
Street.....
City..... State.....

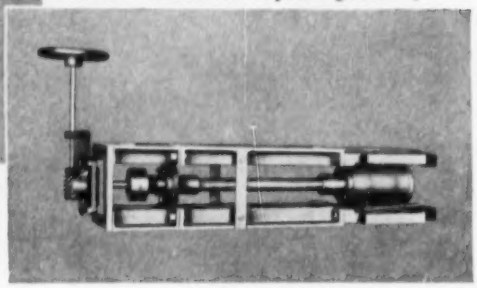
For more data on advertised products, use Readers' Service Cards, last page.



Special 12-inch R-S Butterfly ▲ Valve, with finned lubricated stuffing box, is used for service with hot gases at 1,000° F.

R-S
BUTTERFLY VALVES

All-bronze, 150-pound R-S Valve for operation at—300° F. Valve is installed with 18" insulation in operating cell. ▼



SPECIAL R-S VALVES SOLVE TEMPERATURE, CORROSION, ABRASION PROBLEMS

To meet rugged processing conditions, R-S Butterfly Valves can be built to your requirements. For valve bodies and parts, any metal or other material that can be cast or welded — even plastics — may be specified.

There are a number of materials available to meet extreme working conditions involving corrosion, abrasion, erosion, high heat and pressure. In addition, the R-S Rubber-lined Valve may be specified to resist certain types of corrosion. Every R-S Valve gives you quick and positive closure with any type of controls, uniform control in normal regulating ranges and minimum pressure drop.

If your past experience offers no precedent, you can call on our background in specialized valve engineering to solve material problems.

We have built valves to operate in a temperature range of from —300° F to +2,000° F. For complete information on our complete line of butterfly, ball and cone valves, see our local representative or write S. Morgan Smith Company, York, Pennsylvania.

HYDRAULIC TURBINES · GATES & HOISTS · TRASH RAKES · PUMPS · ACCESSORIES

HYDRODYNAMICS

ROTOVALVES · FREE-DISCHARGE VALVES · BALL VALVES · CONTROLLABLE-PITCH SHIP PROPELLERS · BUTTERFLY VALVES

S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED • TORONTO

Suppliers . . .

Eadie and **Thomas S. Hemenway, Jr.,** were made district representatives for the division.

Donlin has been with General Electric since 1951. In his new position he will cover the Allentown, Pa., trading area where he will handle the division's conduit products, wiring devices and wire and cable lines.

Eadie has also been with the General Electric Company since 1951. His territory will be the Davenport, Iowa, area where he will cover the conduit products and wiring device lines.

Selas Corporation of America has elected **Elmer B. Dunkak** to the newly created position of vice president-sales. Prior to joining Selas, he had been engaged in private engineering practice, with offices in Baltimore and Washington, specializing in management problems relating to products and marketing. For the past 18 months he has served Selas as consultant to the president.

Dunkak

Dunkak has been previously associated with Public Service Electric and Gas Company; with C. M. Kemp Manufacturing Company, Baltimore, as vice president and general manager; and with Davison Chemical Corporation, as vice president—engineering.

(More Suppliers' Notes, Page 257)

PRESUR-ITE

PNEUMATICALLY PLACED CONCRETE AND REFRACTORIES FOR

SUSPENDED WALLS ARCHES FOR PRESSURE VESSEL LININGS HEATERS • BOILERS

- INSULATION
- FIREPROOFING
- STACKS, BREECHINGS.
- REFRACTORY TURN AROUNDS.
- CONCRETE AND STEEL SANDBLASTING
- ENCASEMENT FOR PIPE LINES
- CONCRETE RESTORATION

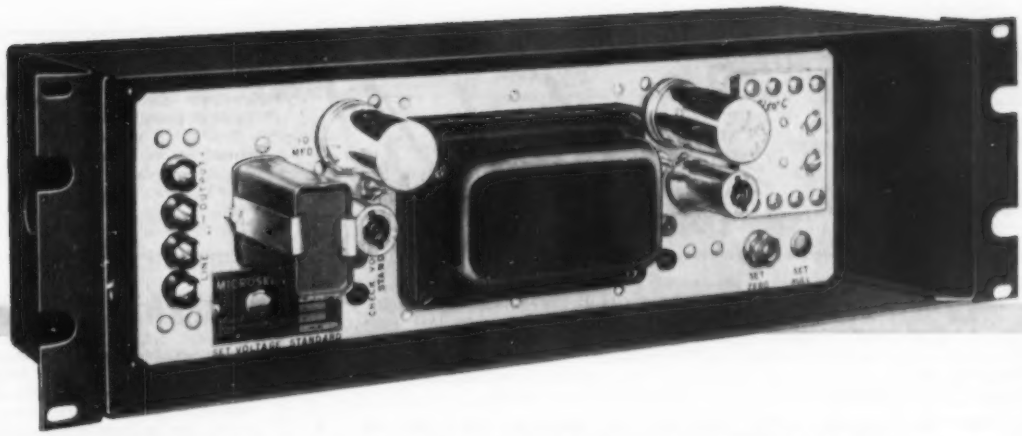
Write for estimates on your proposed project.

GEO. P. REINTJES CO.
REFRACTORY WORK SINCE 1920
2517 JEFFERSON ST. KANSAS CITY 41, MO.
NEW YORK • HOUSTON • PITTSBURGH

REFRACTORY HAYDITE
Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
We sell direct to you.

CONSTRUCTION MATERIALS
CARTER-WATERS
KANSAS CITY MISSOURI
2440 Pennway Phone GRand 1-2570



NEW TRANSMITTING POTENTIOMETER OFFERS 7 BIG FEATURES

★ **Extreme sensitivity. Responds to input change of 3 microvolts or less.**

★ **Self-contained continuous voltage reference. No standard cells.**

★ **No batteries or periodic standardization. Continuous accuracy without drift.**

★ **Simple circuitry. Only 2 single triode tubes.**

★ **Interchangeable range card. Ranges easily changed in the field.**

★ **No slide wires or choppers. Trouble-free operation.**

★ **Fast response: 0.04 second time-constant for 1000° F. span.**

The Series 184 Transmitting Potentiometer is the latest addition to the 'American-Microsen' System of Electronic Transmission and Process Control. With this new unit, it is now possible to measure and control thermocouple temperatures or the signals from such devices as pH amplifiers, gas analyzers, resistance thermometer elements, and other electrical systems.

The extreme sensitivity of the new Potentiometer, plus the high resolution and response speed of the 'American-Microsen' Control System, makes it possible to control process temperatures with the high accuracy required by present-day production demands.

The 0.5 to 5.0 ma. signal output can be transmitted 30 miles or more, over a single 2-wire circuit. In addition to 'American-Microsen' receiver, the signal will operate standard d-c milliammeter indicators and recorders.

OPERATING SPECIFICATIONS

Spans: 6 to 50 millivolts d-c.
Suppression: Up to 5 times span.
Output Signal: 0.5 to 5.0 ma. d-c.
Sensitivity: 0.003 millivolts (0.1° F.).
Repeatability: 0.02 millivolts. (0.6° F.).
Input Source Impedance: 200 ohms maximum.
Effective Input Impedance: 1000 ohms per millivolt of span.
Output Load Impedance: 3000 ohms maximum.
Speed of Response: 0.8 seconds for 99% response on 6 millivolt span. Speed increases with span.

Write today for Bulletin MTT810.

MANNING, MAXWELL & MOORE, INC.

INDUSTRIAL CONTROLS DIVISION, STRATFORD, CONNECTICUT

MAKERS OF THE 'AMERICAN-MICROSEN' TRANSMISSION AND PROCESS CONTROL SYSTEM, 'AMERICAN-MICROSEN' ELECTRO-PNEUMATIC TRANSDUCERS AND ELECTRO-HYDRAULIC CONTROL VALVE OPERATORS.

PETROLEUM REFINER Classified Ads

Petroleum Refiner New Classified Rates

RATES: Regular Classified (undisplayed) set in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. Situation wanted ads, 6 cents per word. Display ads, set in suitably larger type with ruled border, $12 per column inch; situations wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * * * * * * * * * *

FOR SALE

Save on Your INDUSTRIAL TRACK

FOSTER QUALITY — FULLY GUARANTEED

RELAYING RAILS

Handle more cars better—cost less to install and maintain. Foster stocks all Rail Sections 12# thru 175#, Switch Material and Track Accessories.

SEND FOR CATALOGS

RAILS · TRACK EQUIPMENT · PIPE · PILING

L B FOSTER co.

PITTSBURGH 30 • NEW YORK 7 • CHICAGO 4
ATLANTA 8 • HOUSTON 2 • LOS ANGELES 5

SITUATIONS WANTED

MECHANICAL ENGINEER

Well traveled Mechanical Engineer, eight foreign languages spoken fluently with 15 years practical oil refinery experience in installation, piping, turbines hoist, pressure vessels, automatic controls, air, gas, steam, water distribution systems, general preventive and repair maintenance on the field desires position with overseas contractor or oil company operating in Europe or any part of Africa. Service obligation completed and available for employment February 1956. Box 222-R, PETROLEUM REFINER, Houston, Texas.

CHEMICAL ENGINEER

Extensive broad experience including policy decisions, plant operations, construction, pilot plants, research and development on sulphur, inorganic sulphur compounds, sulphur compounds in petroleum, petroleum refining operations, bulk oxygen, caustic, chlorine, soda ash, potash, cement, heavy plant utilities. Engineering degree, some teaching, independent consultation work. Twenty years industrial background. Age 43. Current position not utilizing full capabilities. Desire opportunity to put diversified industrial experience to work examining engineering problems, recommending solutions, supervising operational policy. Box 217-R, Petroleum Refiner, Houston, Texas.

FOR SALE

Master GLASSES

HIGH PRESSURE GASKETS

All sizes to fit your gages
ERNST WATER COLUMN & GAGE CO.
Send for Catalog LIVINGSTON, N. J.

PROFESSIONAL SERVICES

• HIGH voltage electrodeless discharge is on its way as one of the new tools in petroleum refining. High voltage discharge eliminates sludge formation! High voltage discharge removes gases and water! High voltage discharge improves high temperature greases! High voltage discharge makes lubricants from non-lubricants! Let us describe the use of this new tool. No obligation, of course. Research and Development Corporation, 21 East Van Buren Street, Chicago 5, Illinois.

HELP WANTED

REFINERY ENGINEER. Graduate engineer for general refinery engineering work. Good knowledge required of refinery mechanical equipment and some knowledge of steel and concrete design. Minimum experience five years. Salary commensurate with training and experience. Replies should give complete personal data, education, experience, salary requirement. Your reply will be held strictly confidential.

Mechanical Engineer
NATIONAL COOPERATIVE REFINERY ASSOCIATION
McPherson, Kansas

Plant Equipment Inspectors

Graduate engineers with minimum 5 years' experience in design or inspection of petroleum processing plants and equipment. Major part of experience must have been in inspection work entailing general knowledge of all facilities. Develop inspection methods, supervise and conduct inspections and advise operations on codes and equipment limitations in a major oil installation located in Saudi Arabia.

Write giving full particulars regarding personal history and work experience. Please include your telephone number.

Recruiting Supervisor, Box 91

ARABIAN AMERICAN OIL COMPANY
505 PARK AVENUE
NEW YORK 22, NEW YORK

HELP WANTED

• PROCESS ENGINEER—Chemical or Mechanical Engineer with exceptional individual initiative and 2-3 years experience in petroleum refining to assume position with Engineering Department of 20,000 barrel independent Refinery located in East Texas. Send complete resume, Box 223-R, PETROLEUM REFINER, Houston, Texas.

AREA ENGINEERS

Several graduate engineers with minimum 5 years' experience supervising maintenance engineering functions in oil refining or producing facilities, power plants, heavy industrial installations, manufacturing plants, or related operations. To establish technical supervision, procedures, maintenance operations and schedule routine and special work for major oil producing and refining operation with all supporting facilities; i.e., housing, feeding, recreation, etc.

Salary commensurate with background and experience. Write giving full particulars regarding personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 65

ARABIAN AMERICAN OIL COMPANY
505 PARK AVENUE
NEW YORK 22, NEW YORK

PROCESS ENGINEERS

CAREER OPPORTUNITIES IN
SOUTHERN CALIFORNIA

•

for men with a minimum of five years' experience in PROCESS DESIGN for Petroleum or Chemical plants.

•

OFFERING MAXIMUM OPPORTUNITIES FOR:

Utilization & recognition of individual initiative & ability.

Broad responsibilities rather than narrow specialization.

Experience with a wide range of processes.

•

LIBERAL SALARY RANGES, PROFIT SHARING, TOP BENEFITS, & IDEAL WORKING CONDITIONS

Submit resume of training & experience to:

The FLUOR CORP.
ENGINEERS-CONSTRUCTORS
2500 S. Atlantic Blvd.
Los Angeles 22, Calif.

HELP WANTED

■ METALLURGIST to head laboratory and technical sales for leading manufacturer of Stainless Steel processing equipment. Give complete resume and salary requirement. Box 220-R, Petroleum Refiner, Houston, Texas.

ASSISTANT CHIEF ESTIMATOR

Should have 10-15 years experience estimating all phases of engineering and construction work for petroleum refining and chemical process plants. Successful applicant will supervise and prepare estimates for proposals and contracts for a large engineer-contractor organization, reporting directly to Chief Estimator.

Responsibility, leadership qualities, and ability to negotiate with clients are essential, and an engineering degree is desirable. This opening is known to our employees.

Send Complete Resumé with Photo to BOX 224-R, PETROLEUM REFINER, Houston, Texas.

DESIGN ENGINEERS

McKEE's expansion program has created many new openings in our Refinery, Metals and Industrial Divisions.

These are permanent positions with excellent opportunities for advancement in one of the world's largest engineering organizations.

With a fifty-year history of successful operation and continuous growth, McKee designs and constructs Petroleum Refineries, Chemical Plants, Blast Furnaces, Steel Plants, Ore Preparation Facilities and Industrial Plants all over the world. This wide diversification offers a variety of opportunities to qualified engineers, with no age limitations, in the following fields:

PIPING LAYOUT, STRUCTURAL STEEL, CONCRETE, PROCESS HEATERS EQUIPMENT SPECIFICATIONS, LAYOUT AND PROCESS DESIGN. ALSO ELECTRICAL AND PIPING DRAFTSMEN.

McKee offers you top compensation for your work plus the security of a life-time pension. Other benefits include insurance, hospitalization, training program and paid vacations.

Ideal working conditions are provided in large, well-lighted, air-conditioned quarters furnished with the most modern equipment. Ample free parking space is available on the premises.

Adequate housing in good residential communities is available in Cleveland and surrounding suburbs. Excellent schools and colleges offer educational advantages. McKee makes generous allowances for transportation and moving expense.

Interviews will be arranged for those who qualify. Reply by letter giving education and experience. All letters will be answered and kept strictly confidential. PLEASE WRITE TO:

Edward A. Koiner

ARTHUR G. McKEE & COMPANY

2300 Chester Avenue

Cleveland 1, Ohio

HELP WANTED

GAS ENGINEERS (ages 25-38)

A major integrated U. S. oil company operating in South America has challenging career opportunities in an expanding organization for qualified natural gas engineers. Requirements include a degree in chemical engineering and 5 to 10 years of experience in gas and product recovery, gas process engineering, plant engineering and operation, design of gas plants and systems and economic evaluations. Salary and bonus approximately $12,500-$17,000, depending on qualifications and experience. Liberal employee benefits and home vacations with travel expenses. Send complete personal data and experience resume. Interviews will be arranged for qualified candidates. All replies confidential.

Box 1221

Dept. F-14

New York 1, New York

REFINERY CHEMICAL ENGINEERS (ages 26-35)

A major integrated U. S. oil company operating in South America has career employment opporunities in a large modern refinery for qualified graduate chemical engineers. Vacancies exist in an expanding organization at levels requiring from four to eight years of experience in oil refinery operations analysis, process design or development, or refinery economic and efficiency analyses. Salary, including bonus, approximately $12,500-$15,000, depending on qualifications and experience. Liberal employee benefits and home vacations with travel allowances. Send complete resume of education, experience and personal data. Interviews will be arranged for qualified candidates. All replies confidential.

Box 1221

Dept. K-14

New York 1, New York

EQUIPMENT INSPECTORS (ages 25-32)

Career employment opportunities with a major integrated U. S. oil company operating in South America. Vacancies exist in refinery equipment inspection positions at levels requiring two to four years of refinery equipment inspection experience. Candidates must be graduate engineers, preferably mechanical or metallurgical. Salary, including bonus, $11,000-$12,500, depending on qualifications and experience. Liberal employee benefits and home vacations with travel expenses. Send complete resume of education, personal data and work experience. Interviews will be arranged for qualified candidates. All replies confidential.

Box 1221

Dept. Q-14

New York 1, New York

DU PONT

NOW OFFERS

SIX CAREERS

with **Responsibility—Challenge—Recognition**

The Engineering Service Division of du Pont's Engineering Department provides other units of the company with consulting service and technical assistance in increasing capacity and yield, in reducing investment and operating costs, and in improving product quality and plant efficiency. Long-range career positions are immediately available in this division to qualified graduate engineers experienced in these specialized technical areas:

FLUID FLOW

This position will require extensive experience with very complex fluid flow problems, such as are encountered in the following types of equipment: distillation, dust collecting, filtration, grinding, drying, materials handling, absorption-extraction, and agitation and mixing. Successful applicant will develop specialized equipment such as jet reactors, jet compressors, jet absorbers, and pipe line reactors, and provide technical advice on fluid flow problems involved in handling slurries, plastics, highly viscous polymers, dispersion, and semi-solids.

CONTROL SYSTEMS MAINTENANCE

Successful applicant will have had extensive experience in the installation, application, and maintenance of chemical process instrumentation. Duties include: setting up or modernizing plant maintenance forces for proper care of electronic, pneumatic, and hydraulic controls and instrumentation; making cost studies; planning and organizing training programs for maintenance personnel; instituting effective preventive maintenance programs; development of standard procedures for instrument calibration and maintenance; and assistance in establishing efficient installation methods and in start-up of new facilities.

HEAT TRANSFER

Duties include: trouble-shooting on equipment, such as pipe line reactors, fluidized solids reactors, and film driers, where heat transfer is one controlling factor; selection of equipment to determine optimum alternatives; and theoretical analysis of problems in heat transfer in proposed equipment for new applications. Other typical heat transfer problems encountered involve reboilers, inert gas generators, direct fired production furnaces, and indirect fired retorts.

PUMPS AND FLUID MECHANICS

Desired qualifications will include extensive engineering knowledge of and familiarity with equipment used in the fluid mechanics field. Development, research, design, maintenance, or teaching experience with pumps, compressors, jets, and seals is desirable. Responsibilities of the position will involve selection of equipment and recommendations for equipment modification for special applications.

AUTOMATIC PROCESS CONTROL

Position requires broad and detailed experience in research, application, consulting, or design of automatic controls for chemical, mechanical, or aeronautical applications. The successful applicant will provide consulting advice to operating plants and development laboratories on the application of automatic control to new processes and for the improvement of existing processes. Position will require the study of controllability by analysis of open and closed loops and the measurement of control characteristics of instrument components.

PETROCHEMICAL PROCESS & EQUIPMENT

Successful applicant will analyze existing and proposed chemical processes for utilization of petroleum processing equipment and methods for obtaining greater yield and lower equipment investment, particularly with respect to hydrocarbon processes. Typical operations to be evaluated include solid fluidization, adsorption, reforming, and catalysis. This requires broad familiarity with equipment such as hypersorbers, distillation columns, cracking furnaces, low temperature refrigeration systems, and compressors. Other duties include trouble-shooting and economic evaluation of alternative processes and equipment.

Interviews in Los Angeles
Feb. 26-27-28-29 (Sun-Mon-Tues-Wed)
For appointment, please call
Mr. J. C. Costello, Jr. MAdison 9-3868

Interviews in San Francisco
March 4-5-6-7 (Sun-Mon-Tues-Wed)
For appointment, please call
Mr. J. C. Costello, Jr. YUkon 6-2180

Or you may send complete resume, including details of education and experience, to:
Mr. J. C. Costello, Jr.
Engineering Department

E. I. du Pont de Nemours & Co., Inc.
Wilmington 98, Delaware

DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living
...through Chemistry

Suppliers . . .

Stauffer Chemical Company has promoted **James H. Begley** to Western division sales manager for industrial chemicals. Begley, who will make San Francisco his headquarters, has been Chicago district sales manager. He had been with the Stauffer Sales department for about 12 years.

Conoflow Corporation has expanded its Philadelphia sales office operations. **Harry J. Hartz** has been appointed district manager. He will be assisted by **William E. Hagan**, who will serve as district sales engineer.

Both Mr. Hartz and Mr. Hagan were engaged in sales-engineering work in the home office before this appointment. The Philadelphia territory covers Eastern Pennsylvania, Southern New Jersey and Delaware.

Diamond Alkali Company has made **Kurt Albrecht** a research chemist in the Detergent section of the Silicate, Detergent, Calcium division

Albrecht comes to the Diamond organization from Calgon, Inc., a division of Hagan Corporation in Pittsburgh, where he has been a chemist and group leader in detergent research for the past 18 years.

In his new post with Diamond, Albrecht will be concerned principally with development of new detergent formulations, direction of technical service work on metal-cleaning applications of Diamond chemicals, and improvement of analytical techniques.

The International Nickel Company, Inc., now has **George T. Paul** as a member of the Development and Research division's Corrosion Engineering section in New York. One of Dr. Paul's first undertakings will be the preparation of a book on the corrosion resistance of stainless steels.

A former member of the faculty of Princeton University, he was on the staff of the Chemical Engineering Department for 10 years as an instructor and an assistant professor. While at Princeton he was also associated with the Textile Research Institute as a research engineer.

Koppers Company, Inc., has purchased 80 percent of the common stock of Durethene Corporation, makers of polyethylene film and tubing.

Under terms of the agreement, Koppers has purchased the controlling interest in the firm in a straight cash deal. Durethene will we operated as a partially-owned subsidiary of Koppers. General supervision of the company will be under the Chemical division of Koppers.

Durethene Corp. occupies two plants, one at Chicago and the other at Los Angeles. A large plant to house the Chicago operations of Durethene is now under construction at Chicago. It will be completed in April, 1956.

HELP WANTED

Mechanical Engineers

EMPLOYMENT OPPORTUNITIES IN

South America

Attractive staff positions available with affiliates of STANDARD OIL COMPANY (N. J.).

Must be thoroughly qualified and experienced in design and/or maintenance of refinery or chemical plant equipment including piping, pressure vessels, heat exchangers.

Attractive salaries, liberal annuity and savings program offered.

Write, giving age, marital status, education and details of previous experience.

Box 308-D
RADIO CITY STATION
New York 19, N. Y.

HELP WANTED

PROCESS ENGINEER

Chemical Engineer with a minimum of three years refinery experience in operations or process design.

Work will include process engineering closely integrated with operations of new independent refinery which includes crude distillation; catalytic cracking, reforming, polymerization; delayed coking and sulphur manufacturing.

Please send complete resume including salary requirements to:

GREAT NORTHERN OIL COMPANY
P. O. Box 3596
Saint Paul 1, Minnesota

Standards Engineer

Attractive opening in Esso Engineering for a Standards Engineer. Will work with a group of engineers preparing engineering standards and standard purchase specifications for oil refinery equipment.

Candidates should be graduate engineers not over 35 years of age. Broad background of at least five years experience with oil refinery equipment desired.

Give full and specific details of education, experience, desired salary, availability date and references.

All inquiries will be considered promptly and held confidential.

Esso Research and Engineering Company
(Formerly Standard Oil Development Company)
Personnel Division
P. O. Box 51 Linden, N. J.

ENGINEERS DESIGNERS

SAN FRANCISCO assignment

Recent design experience on petroleum refineries, chemical plants, steam power plants, or related projects.

CHEMICAL MECHANICAL

Engineers with thorough knowledge of heat exchanges, pumps, piping layouts, specification work and analysis of bids.

PIPING

Designers with drafting and layout experience on steam or process piping.

Please write furnishing complete chronological experience record and salary history. Also, full details regarding education, salary required, business and character references.

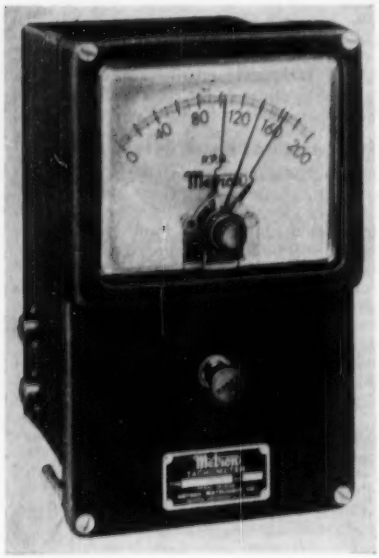
BECHTEL CORPORATION
220 Bush St., San Francisco 4, Calif.

HELP WANTED

Exceptional Opportunity for DISTILLATION ENGINEER

Large progressive manufacturer of organic chemicals wants chemical engineer skilled in the design and operation of distillation facilities. Should have about five years experience with multi-competent systems, application of instrumentation to such systems, interpretation of physical chemical data, and optimum operation of equipment for maximum production of best quality product with greatest efficiency. Experience in the petroleum or petrochemicals field is acceptable. Should be able to analyze the economic aspects of distillation problems and recommend the best solutions. Must interpret laboratory results and obtain pilot plant data. Also must attack problems from the theoretical and analytical point of view. Ability to express thoughts and work with other members of the group is necessary. Replies held confidential. Please send complete resume including salary expected and details of education and experience. Our employees know of this ad. Box 225-R, PETROLEUM REFINER, Houston, Texas.

What's New In Equipment . . .



Tachometer . . . A new tachometer which not only indicates speed but actuates self-contained power relays that signal overspeeds and underspeeds, has been announced by Metron Instrument Company. The unit is ideal for use in sounding alarms, turning on light signals, stopping or starting equipment, opening or closing valves, controlling speeds or for many other similar applications.

The high and low limit pointeres are independently adjustable. These pointeres act as a sing-pole double throw switch with the regular speed pointer acting as the switch center arm. A manual reset push button is used to reset the tachometer after the relays have signalled a high or low speed.

The unit is available in any one of 48 different scales, marked in any rate such as RPM, FPM, or sheets per hour. For additional information on this new tachometer **just circle E1 on the card.**

Magneto Ignition Unit . . . The Bendix Aviation Corporation has announced a new ignition system for heavy-duty high compression gas engines. The matched system combines a new type Bendix LC magneto with the company's Hi-V transformer coil.

This combination, is intended to meet the exacting requirements of large stationary industrial engines of 6 to 16 cylinders ranging from 1,000 to more than 4,000 horsepower. It is said that the adjustment of the master breaker of the LC magneto is normally required only once a year, during major engine overhaul periods.

In addition, this magneto has a high output at normal cranking speeds and does not require an impulse coupling for starting. Magneto shafts are mounted on sealed ball bearings and cam and follower materials are matched for minimum wear. For details on this system, **just circle E2 on the card.**

New Line of Centrifugal Pumps Permits Leak-Free Operations

General Purpose Centrifugal Pump . . . Two new lines of leakless general purpose centrifugal pumps—the "Electri-Cand"—have been announced by Allis-Chalmers.

Designed for handling precious or hazardous liquids where no leakage is permitted, the pumps are available in a fractional horsepower line (C-10) to include motors through 2 hp, and an integral horsepower line (C-11A and C-11B) covering motors above 2 hp. They are capable of accommodating heads to 250 feet and temperatures to 250 F. and can be had with capacities to 500 gpm.

The "Electri-Cand" pump utilizes the canned motor principle in which the rotor of the driving induction motor rotates in the fluid being pumped and is connected directly to the pump impeller. This construction requires no packing or mechanical seals. All rotating elements of pump and motor are contained in a thin wall cylinder or "can" making an absolutely leakproof unit.

The Type C-11A integral horsepower pumps have long-lived fluid piston radial bearings throughout. These are supplied with liquid through an internal connection with the pump casing discharge nozzle.

The liquid is forced through the bearing piping to the bearings, pressurizing the bearing pads. The pressure which is self-adjusting, keeps the shaft centered in the bearing. Leakage from the bearing is collected and returned to the pump suction. Metal to metal contact only at startup virtually eliminates maintenance.

Adding to the long life of the fluid piston bearing is the fact that special design can be applied to overcome any heat added to the stator by hot liquid.

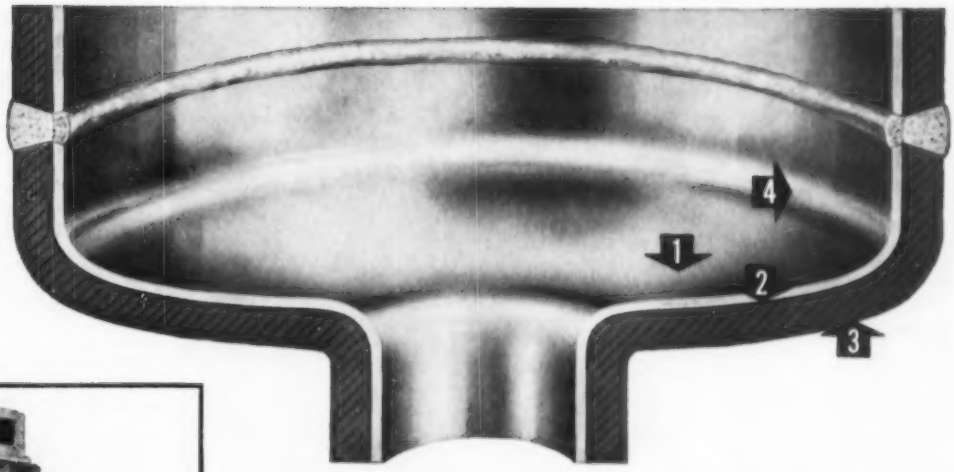
Construction of the Type C-11B pump is similar to that of the C-11A except that the external piping is eliminated and less costly carbon sleeve radial bearings are used. There is some circulation of the liquid to wet the bearings and to flush out any solids that might get into them. Elimination of the bearing piping makes it possible to replace stators without opening the system. Carbon sleeve bearings have a shorter life than fluid piston bearings and cannot poss solids without damage. For detailed information, **circle E3 on the card.**

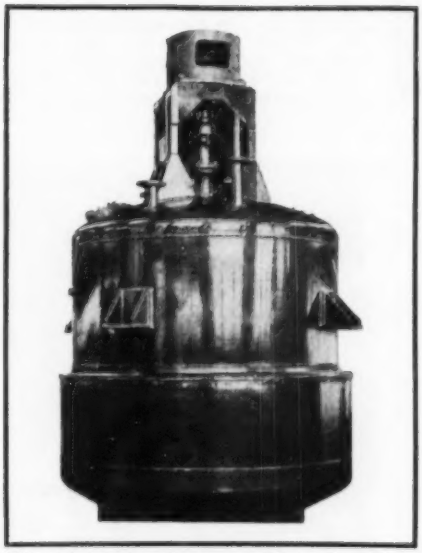
High-Temperature Brazing Flux . . . The Air Reduction Sales Company has announced a new high temperature brazing flux. This material is for use in the brazing of chrome and nickel alloys. The stainless steel assemblies used throughout the industry are good applications for this new flux. It is free flowing and active in a temperature range of 1400 F to 2000 F. For information on this material, **just circle E4 on the card.**

Fluorocarbon Lining . . . The M. W. Kellogg Company offers a new fluorocarbon plastic laminate with high temperature and extreme chemical resistance. The material consist of a thin—10-12 mil—continuous layer of KEL-F Plastic on glass cloth.

It can be adhesive-bonded to almost any contoured surface. Vessels ranging from rectangular plating tanks to complex reactors involving flanged pipe connections and dished heads, have been lined throughout with the material It is said that the KEL-F Plastic laminate installed on carbon steel is more than competitive with many alloy metals.

Still lower material costs are expected for a lighter gage laminate designed for applications requiring the special anti-sticking qualities of this fluorocarbon plas-





This nickel-clad steel agitator kettle handles chlorinated hydrocarbons under severe operating conditions.

1. **ECONOMY**—High-alloy layer—usually 10% or 20% of total plate thickness—assures corrosion and abrasion resistance, long equipment life.
2. **DESIGN FREEDOM**—Integral bond allows design and fabrication of shapes to meet process and space needs.
3. **STRUCTURAL STABILITY**—Carbon or alloy steel backing gives required strength and rigidity at lower cost.
4. **LESS MAINTENANCE**—Smooth, hard surfaces, rounded corners and sloping bottoms mean easy cleaning and draining.

CLAD STEEL EQUIPMENT IS **EASIER** TO CLEAN AND MAINTAIN

In those parts of your process where unscheduled shutdowns mean a big operating loss, clad steel equipment's smoother, more uniform surfaces mean easier cleaning and drainage to help reduce over-all corrosion rates. Preventive maintenance is simplified, for clad tanks and vessels are easier to inspect than lined equipment. The layer of high-alloy cladding gives all the protection and corrosion resistance of solid alloy material, does not permit seepage or crevice corrosion.

Sixteen types of Lukens' clad steel—stainless, nickel, Inconel, Monel, copper—give you these advantages at *savings up to 50%* in material costs over solid high alloys. The API-ASME Code permits full gage consideration for design purposes because cladding and backing are bonded over their entire surface.

Clad steel equipment assures long life with minimum maintenance, economy of field erection, resistance to thermal shock and easy modification as processes change. Take advantage of these benefits, check with *qualified* equipment builders. Working with your engineers and consultants, they can help you get more for your equipment dollar. We offer the widest selection of clad steels available anywhere and we can help in the selection of the type of clad steel that best suits your needs. If you would like more information, consult one of your equipment builders or write Manager, Marketing Service, 752 Lukens Building, Lukens Steel Co., Coatesville, Penna.

LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEEL PLATES AND HEADS AVAILABLE

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

tic. It is stated that development of this material gives designers a new approach to lining problems and the breadth of applications is very high.

The laminate is now available in sheets measuring 36 inches by 46 inches. Longer sheets, 36 inches, in width, can be made on special order. Sheets using Kellogg's Kel-F material are produced by the Garlock Packing Company, and the U. S. Gasket Company. For detailed information, **circle E5 on the card.**

Safetywell Thermocouple Assembly . . . The Conax Corporation has announced its new positive pressure seal, Thermocouple Well Assembly. It is intended to provide full protection in case of well rupture and permit small diameter thermocouples to be used with an even greater safety than has previously been achieved by other methods.

Fast response with the resulting accuracy is insured by bottoming a butt welded thermocouple in the formed tip of a small diameter well. This fast response feature combined with safety is made possible in this unit. By completely sealing in the thermocouple elements, the safety well minimizes oxidation and insures the initial accuracy of light gage thermocouples for the life of the well.

Range of operation of the standard, small diameter, fast response unit is from vacuum to 3000 psi and temperature range is from —300 F. to +1850 F. The well is made of type 304 stainless steel tube with tip spun closed and sealed with homogeneous weld. **Circle E6 on the card.**

Safety Muffler . . . The Burgess Manning Company now offers a new water separator snubber which controls the exhaust temperature to safe limits or semi-hazardous areas. It also provides the added features of exhaust silencing and spark arresting in the same unit.

This unit, the WSS-4 Snubber, can be installed on internal combustion engines for pumping units, vehicles and the like. Test runs showed the water temperature in the reservoir to be between 160 F and 180 F and the temperature of the exhaust in the tail pipe to be between 200 F and 244 F. For information on this equipment, **circle E7 on the card.**

Alloy Y-Type Strainers . . . Armstrong Machine Works announces development of six sizes of carbon moly steel strainers. The new Y-type pipe strainers for oil, gas, air, water and steam lines are suitable for pressures to 900 pounds and temperatures to 900 F. Maximum pressure at 100 F. is 1800 psig.

The strainers are available in ½ inch through 2 inch sizes, either screwed or socket weld. Sizes 1¼-inch, 1½-inch and 2-inch have bolted retainer plates. Smaller sizes have straight thread screwed bushings. **Circle E8 on the card.**

Tube-Expander . . . The Thomas C. Wilson Company has introduced its new tube expander drive, Torque-Air-Matic. This unit is exclusively air driven and has torque out put calibration in terms of foot-pounds. The torque indicated is from the out put spindle which gives a true indication of tube rolling condition.

Air consumption for the roller is 12 cfm when producing 14 pounds torque with 90 pounds per square inch psi. The unit is

Petrochemical Handbook Reprint

Now available in reprint form, the Petrochemical Handbook Section of PETROLEUM REFINER'S December, 1955, issue contains graphic data on:

80 manufacturing processes
10 separation processes
. . . of the most interesting Petrochemicals

Here's your chance to add to your library the latest job help information on petrochemicals. Available for only $1.00 per copy, you may obtain this reprint by addressing:

REPRINT DEPARTMENT

PETROLEUM REFINER

P. O. BOX 2608, HOUSTON 1, TEXAS

GUNITE
Since 1915
CONCRETE
SAND AND CEMENT
"Placed by Air"

We have the equipment, personnel and experience to complete any and all GUNITE work regardless of size or location.

Send for specifications and bulletins

GUNITE CONCRETE & CONST. CO.
1301 WOODSWETHER RD., KANSAS CITY 5, MO.
2016 WEST WALNUT, CHICAGO 12, ILLINOIS
3206 HOUSTON, HOUSTON 9, TEXAS
3545 LINDELL BLVD., ST. LOUIS 3, MO.
Milwaukee and Twin Cities—Denver—New Orleans

STEEL PIPE and TUBING

- CARBON MOLY
- CHROME MOLY
- STAINLESS
- HASTELLOY
- CARBON

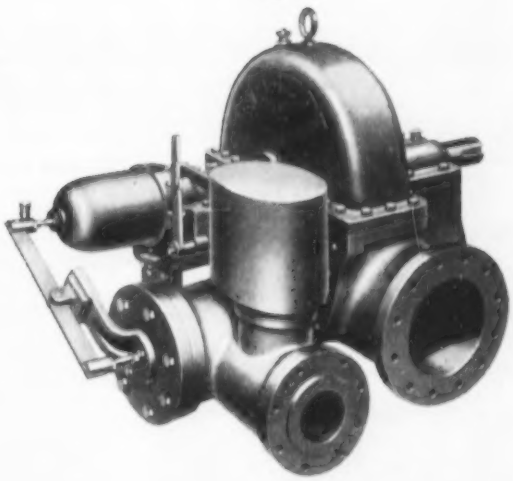
ALL SPECIFICATIONS – ANY SIZE
Write for Stock List
Send us your surplus lists

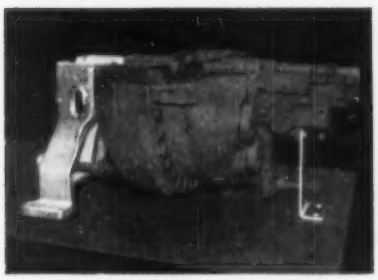
MIDCONTINENT TUBE SERVICE, Inc.
2308 Oakton St., Evanston, Ill., Davis 8-4030

You're ahead 6 ways...

with the ELLIOTT YR TURBINE

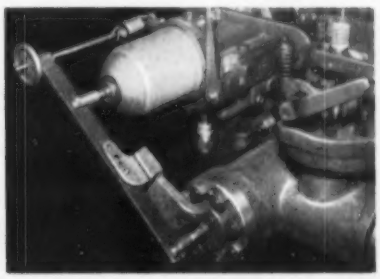
The simplicity and adaptability of the Elliott YR Turbine give it advantages that put it well ahead for pump, fan, compressor and other machine applications. These features all add up to the kind of long-term dependability that makes Elliott the preferred choice among plant engineers everywhere. Bulletin H-22A gives complete details. Write to nearest district office or to Elliott Company, Jeannette, Pa. for your copy.





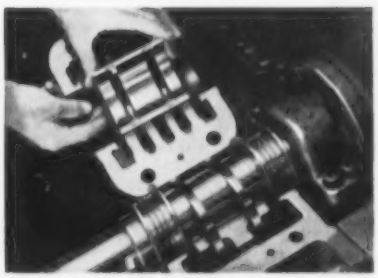
True Centerline Support

Assures alignment cold or hot and simplifies installation. Note how the sturdy exhaust-end pedestal is separated from the hot turbine casing.



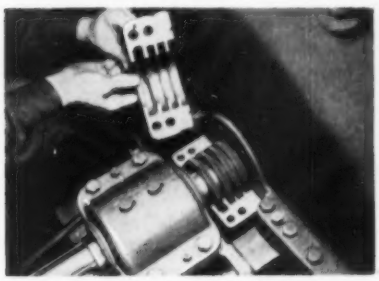
Simple, Reliable Governing System

Weather-proofed standard governor, with fly-ball type speed-sensitive element, mounted directly on the turbine shaft, is the simplest, most rugged, and reliable type of governing.



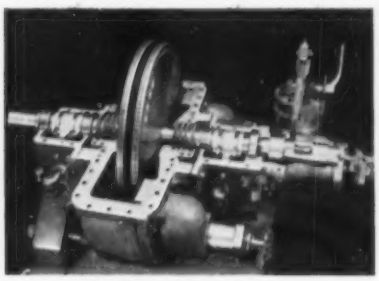
Liner Type Bearings

Bearing cap is easily removable so that the inexpensive liner type bearing can be readily inspected or replaced. Labyrinth seals effectively protect the bearings against the elements.



Accessible Shaft Seals

You don't have to raise the upper half of any YR turbine casing to get at the shaft seal for inspection or ring replacement. Just remove a few bolts and the steam-tight packing gland cover comes off.



Self-Locating Rotor

Permanently fixed locating bearing makes it possible to drop the turbine rotor into perfect position without requiring adjustments.

Interchangeable Components

Renewal parts inventories are reduced by the interchangeability of wearing parts between turbine frame sizes. Possible modifications make turbines suitable for special requirements while retaining parts interchangeability.

ELLIOTT Company

H5-1

TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

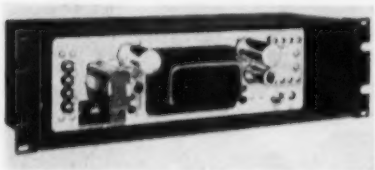
New Equipment . . .

self contained and requires no control cabinets, cables or other connections. The roller has a pistol grip design but is furnished with an auxiliary handle that may be swiveled to any position desired by the operator. An oil reservoir has been built into the handle.

The control section is independent of the motor and lubrication is permanent. The chuck snaps on. The total weight with the auxiliary handle is approximately 7½ pounds and the length is 10 inches. For detailed information on the Torque-Air-Matic Tube Roller, **circle E9 on the card.**

Transmitting Potentiometer . . . A transmitting potentiometer based on an entirely new operating principle has been introducted by the Industrial Controls division of Manning, Mexwell & Moore, Inc.

The unit complements the "American-Microsen" Electronic Process Control Sys-



tem. It permits mersurement and control of low voltages while drawing negligible current from the source.

It is available as a thermocouple pyrometer or to measure direct-current output of electrical transducers. No slidewire, batteries, standard cell, "chopper" or converters are used. The circuitry is simple using only two vacuum tubes. The input voltage is automatically balanced against the output signal by use of a "Microsen" balance.

The Transmitter is available in ranges from 6 to 50 millivolts (200 F. and up), with zero suppression up to five times the span. Sensitivity of the unit is high, better than 3 microvolts, which permits extremely accurate control of temperatures when used with the "American-Microsen" Electronic Control System. For detailed information on this new transmitting Potentiometer, just **circle E10 on the card.**

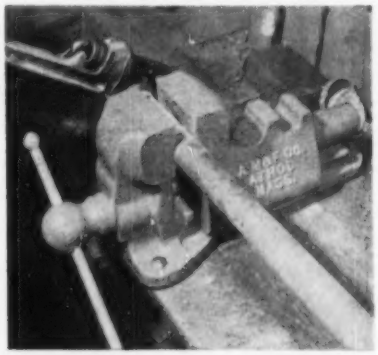
Torque Control Impact Wrench . . . A new air operated nut running tool which impacts the nut to a desired preset torque for precision tightness, then automatically shuts itself off, has been developed by Ingersoll-Rand.

The action of the mechanicism is likened to that of a pogo stick, which bounces evenly on soft ground, but suddenly rebounds higher when it strikes a hard surface. While the nut is being run to required torque, the new Impactool operates at normal power and speed.

When required torque is reached and nut-running resistance is equal to the stress preset in the torsion bar, the impact mechanism rebound and trips a rubber-faced shutoff valve.

Torque setting is simple. It can be easily and quickly set by using a jig which turns a torsion bar and the calibraton collar to the desired reading. The torque setting remains constant for any nut-running operation until the adjustment is changed. Releasing the trigger resets the tool automatically to the same torque for the next nut. The torque control is consistently accurate and numerous tests have demonstrated its consistency. The operation is reversible with full power in either direction. Maintenance is minimized since there is no clutch, hydraulic or other special features.

The torque is factory preset at 320 feet pounds, and can be easily adjusted through a range of 14 calibrations up to a maximum of 550 feet pounds. This is adequate for running ¾ inch and ⅞ inch high strength bolts. A smaller size impact tool is also available with torque ratings up to 90 feet pounds. The large unit, model 5340T, weighs 31½ pounds, and is 24 inches long. The small unit, model 5040T, weighs 6¾ pounds and is 10½ inches long. For details, **circle E11 on the card.**

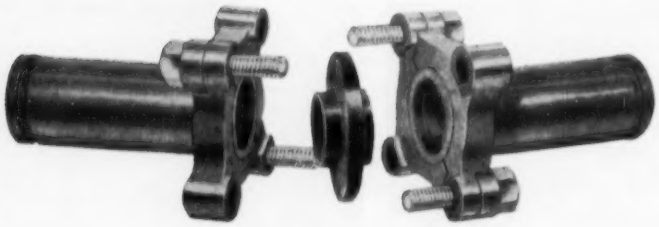


Heavy Duty Vise . . . The Athol Machine & Foundry Company has introduced a new heavy duty vise weighing 150 pounds and is of semi-steel construction. Gripping surface is 5 inch by 4 inch on the face of each jaw with a total depth of 6 inches.

Machined into the heat-treated tool steel jaw facing, is a full 5 inch long pipe

Gaco

RUBBER-LINED SYSTEM SIMPLIFIES YOUR PIPING PROBLEMS . . .



The GACO split flange is the ultimate in engineering simplicity. Pipe is prepared for joining by grooving ends and counterboring rubber lining. Rubber gasket is fitted into the pipe ends. Split flanges are wrapped around grooved pipe section and bolted together to complete the assembly of the GACO joint. The GACO System is adaptable to any type of rubber-lined pipe installation.

Save time and reduce costs on piping installations and repairs. Write for a copy of GACO Rubber Lined Pipe System catalog today.

GATES ENGINEERING COMPANY • WILMINGTON 99, DELAWARE

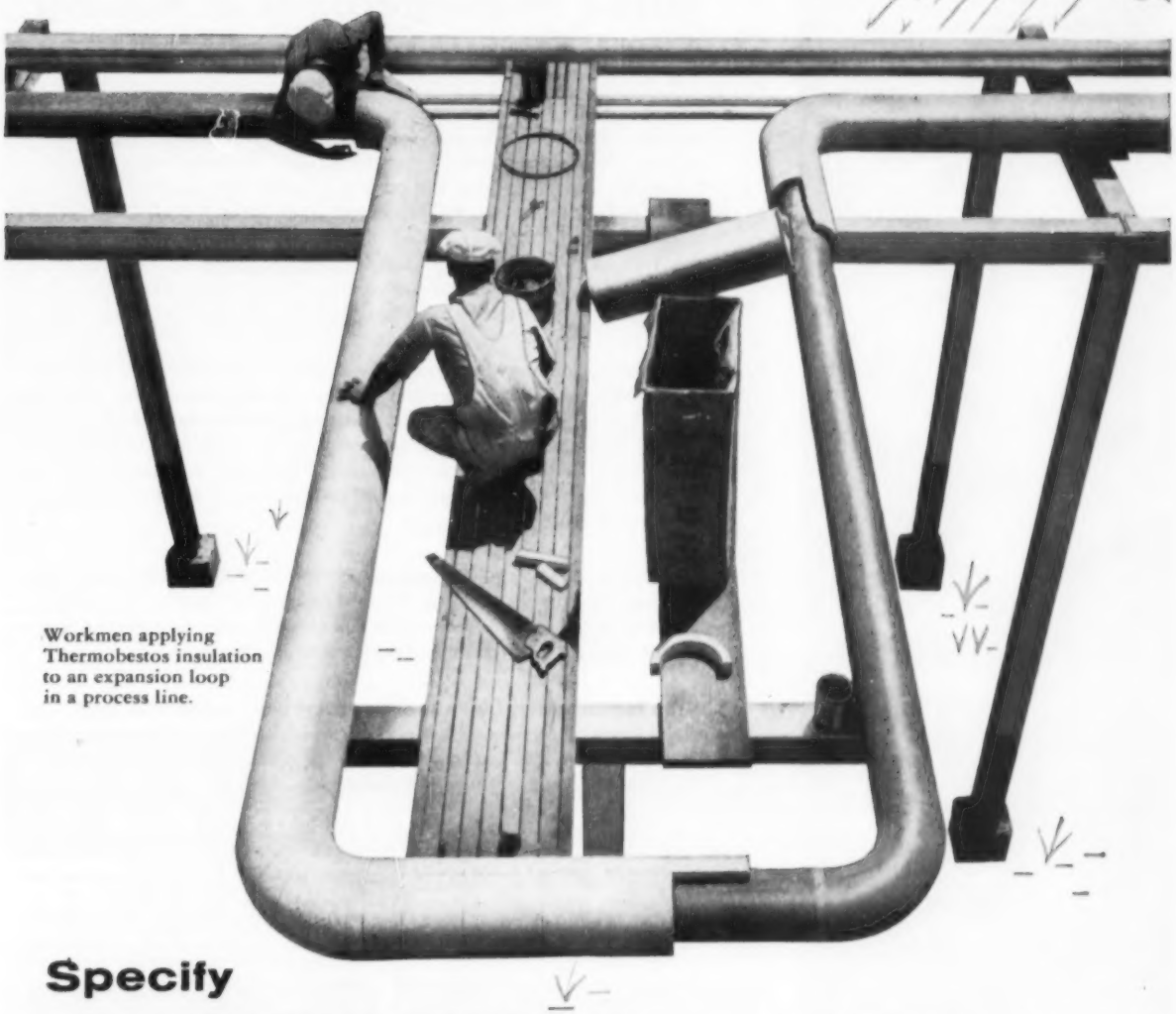
1. ELIMINATES DESIGN ENGINEERING
Rubber-lined pipe can be cut to size and installed at the job site from a sketch of the installation.

2. 360° ROTATION . . .
Flexibility of the free turning GACO split flange principle assures that every installation will line up on the job. The GACO flange hole pattern rotates around the pipe, conforming to all standard, rubber-lined fittings.

3. FOUR WAY SEALING . . .
GACO rubber gasket has a four-way sealing feature, giving leak-proof service up to 1600 pounds pressure and 28" vacuum.

4. UNINTERRUPTED FLOW . . .
The GACO joint presents uninterrupted flow to the liquid stream through the entire GACO pipe system.

When you're fighting the weather as well as heat loss



Workmen applying Thermobestos insulation to an expansion loop in a process line.

Specify

J-M THERMOBESTOS® the heat insulation designed for outdoor process industries

Here's proof that rugged physical strength and high insulating efficiency can be combined in one material. J-M Thermobestos is strong and rigid, yet light enough for easy handling and fast application. It is not damaged by prolonged wetting. Its hard composition resists crushing and will withstand unusual service abuse. The low conductivity compares favorably with other accepted industrial insulations.

This unique combination of properties means excellent temperature control and minimum maintenance cost for oil refineries, chemical processing plants and other plants with outdoor vessels and hot piping.

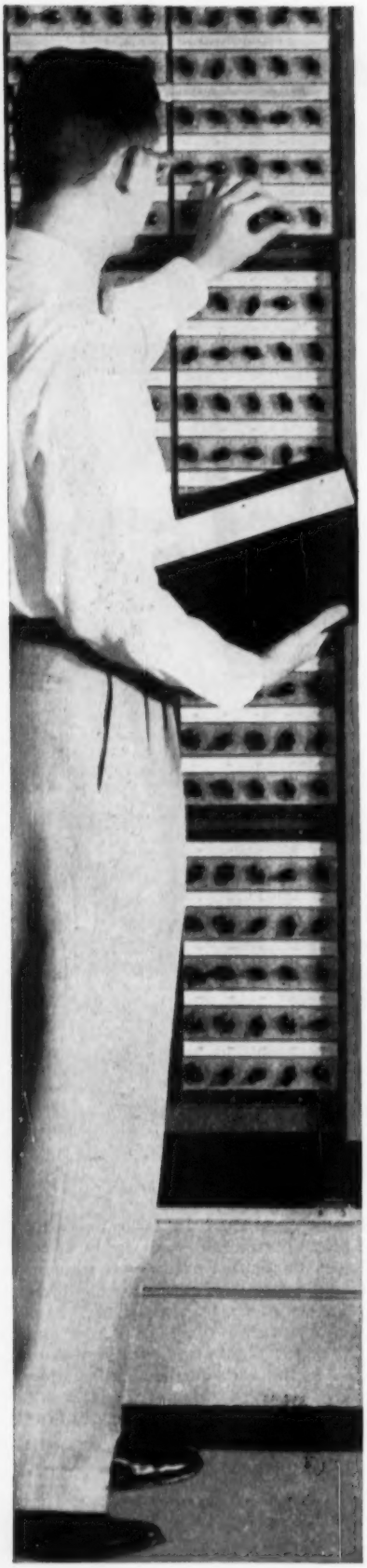
Made from calcium hydrosilicate, Thermobestos is molded to size for proper fit. Its high strength makes it particularly adaptable for time-saving shop prefabrication of fittings and bends. Furnished in large sections, Thermobestos is easy to apply. It reduces the number of joints. In pipe insulation form, it comes in a complete selection of sizes up to 24″ x 3″ half-sections. Also available in 6″ x 36″ and 12″ x 36″ blocks in a full range of thicknesses. For further information write to Johns-Manville, Box 60, New York 16, N.Y. In Canada, Port Credit, Ontario.

JM PRODUCTS

Johns-Manville *first in* INSULATION

MATERIALS · ENGINEERING · APPLICATION

For more data on advertised products, use Readers' Service Cards, last page.



Panalog Information Systems guide management in raising plant output and profit

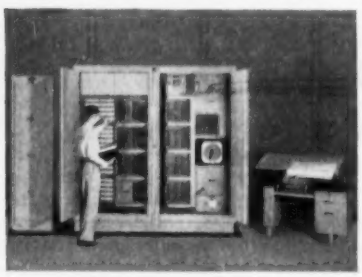
Panalog 605 Information System supplies management control information. Now, operating personnel and management can receive organized digital information on any process, instantly and continuously. Information can be presented in a variety of forms for immediate control action as well as for engineering and accounting analysis. A typical presentation method employs an electric typewriter and patented log chart. Readout can also be made on punched or magnetic tape, punched cards, or can be fed directly to computers.

Periodically logs and continuously scans. A precision servo measuring system quantizes process variables during automatic, periodic logging. A high-speed electronic measuring system detects off-normal conditions during continuous scanning of all variables. Normal and return-to-normal values are printed in black—off-normals in red. A complete log of all variables as well as a summary of off-normals can be made at any time.

Completely flexible and expandable. Panalog components are standardized, packaged modules. The system can be easily expanded or modified in the field. The Panalog 605 is sufficiently flexible to supply digital information for any management requirement.

Write for literature. Literature presenting a comprehensive treatment of the Panalog 605 is available. If you wish, a Panellit representative in your area will be happy to discuss the possibilities that a Panalog Information System offers your company.

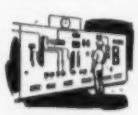
Full scale, adjustable, high and low off-normal limits are provided for each input variable. Basic system capacity, 200 points with one electric typewriter — can be expanded. Accuracy, ± 25% of full scale range. Logging speed, approximately one line per minute. Scanning speed, five points per second, between logs.



Logged values are grouped by processing unit on chart. Audio-visual alarms accompany detection of off-normals. When scanning, off-normal values are identified and printed in separate chart area. Totalized and averaged values as well as plant efficiencies can be automatically computed and recorded by the system.

U.S. Pat. No. 2,701,748

Engineered Information Systems For Industry



Graphic Panels
Control Centers

Panalarm
Annunciators

Instrument
Services Division

PANELLIT

PANELLIT, INC.

7415 N. Hamlin Ave., Skokie, Ill.
Panellit of Canada Ltd., Toronto 14

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

grip, which will take a pipe or rod from ⅛ inch to 6 inches in diameter and give a full 5 inch long grip on both sides. This unit is intended for rough surface either out doors or indoors. If you'd like information, **circle E12 on the card.**

Hydraulic Crane Boom . . . A new 64 hundred-pound capacity hydraulic crane unit has been introduced by the Pittman Manufacturing Company. The unit is the model 60 Pittman Hydra-Lift. The Hydra-Lift installs on any truck 2 tons or larger. Loads can be positioned by extending the boom hydraulically or by lowering the boom on the full load.

This is an important operating feature in making lifts into obstructed areas. The out riggers for the unit are hydraulically operated. All the operator need do to set the out riggers is to push two levers which are accessable at the normal operator position. The unit is available as a packaged unit ready for installation in a relatively limited time and at low cost.

Seamless steel tubing is used almost exclusively in place of hoses for hydraulic fluid. This simplifies maintenance cost and downtime. For full details on the model 60 Hydra-Lift, **just circle E13 on the card.**

Inspection Unit . . . Alcar Instruments, Inc., has introduced a new ultrasonic measuring device. It is used for non-destructive testing of materials and is economical in price. The unit is called the "Inspectrogage 55" and gives a visual indication of material thickness and requires access to only one side of the measured work.

Any flaw due to discontinuity or lack of bonding is indicated by a shift or disappearance of the thickness reading. The unit consist of an oscillator, cathode ray oscilloscope and a transducer which transmits ultrasonic vibrations into the tested material.

When the frequency oscillator is same as the response frequency of material, a vertical marker appears on the face of the tube indicating exact thickness of material by pointing to a calibrated screen. For more information, **circle E14 on the card.**

Covered Woven Wire Slings . . . A new line of Gripper woven wire Slings is now available with plastic or Neoprene

Prolong the Life of Vessel Liners by Armoring them with . . .

KLEMP **HEXTEEL** ▶

Hexteel is an armor and retainer for castable refractory monolithiclinings used for cat crackers, reactors, regenerators, fractionators, heaters, strippers, risers, stacks, cyclones, ducts, breeching, furnaces and tanks.

and FLOORSTEEL ▶

Floorsteel is an armor and retainer for monolithic liners applicable to small diameters for pipe linings, heads, plenum chambers, sumps, stacks and furnaces.

Hexteel and Floorsteel carbon or stainless steel armors and retainers prolong the life of vessel liners by resisting abrasion and corrosion. Our engineering department is prepared to design your total lining requirements. Whatever the destination, we will deliver your Hexteel or Floorsteel world-wide in record time!

Emergency delivery of Klemp Hexteel via air transport

Write for your FREE copy of "Serving the Oil Industry for Over 40 Years"

KLEMP METAL GRATING CORP
6601 South Melvina Avenue
Chicago 38, Illinois

KLEMP METAL GRATING CORPORATION PR
6601 South Melvina Avenue, Chicago 38, Ill.
Gentlemen:
Kindly send me literature describing Hexteel and Floorsteel applications in the petroleum and chemical industries.
Name
Firm
Address
City Zone State
Phone

For more data on advertised products, use Readers' Service Cards, last page.

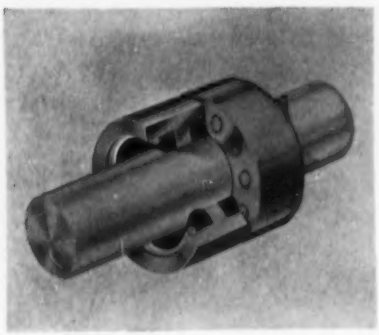
New Equipment . . .

covering is available from The Cambridge Wire Cloth Company. The new protective covering makes the sling particularly suitable for handling operations where highly finished or machined surfaces are to be handled.

The protective covering has an extremely long life under normal use and can be applied to slings of any length or width. It has no effect on the flexibility of the sling and thus the slings can be used either in basket or choke hitch.

This type sling is particularly desirable for use in the machine shops handling equipment components to avoid damage. For detailed information, **just circle E15 on the card.**

Seals for Large Diameters . . . Magnetic Seal Corporation offers a shaft seal (Model No. 30) employing magnetic inserts and adaptable to both high and low pressures. By providing improved balanced pressure, the magnetic shaft seal eliminates warpage on the face sealing surfaces. Thus there are never any hot spots or subsequent possibilities of leakage. These seals are extremely compact and require far less axial space than any spring-loaded seals. **Circle E16 on the card.**

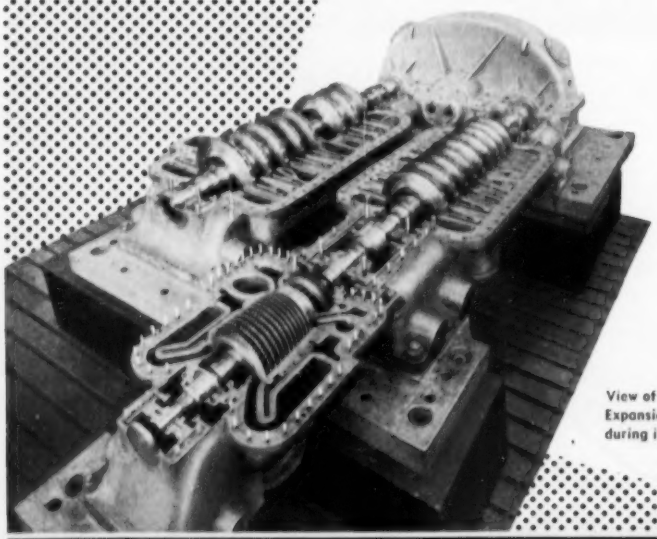


Gas Analyzer . . . Beckman Instruments, Incs., has announced the new Beckman Model 150 RF Gas Analyzer. This is a rugged mass spectrometer that operates on a radio frequency principle instead of the conventional magnet-type mass spectrometer.

The instrument has been developed for monitoring refinery process streams and gases from other sources. The unit determines identity by measurement of molecular weight. **Circle E17 on the card.**

Hydro-Electric Work Tower . . . A new hydro-electric elevating work tower for one-man use is announced by Safway Steel Products, Inc. Powered by a ¾ hp. single-phase electric motor, the ML-4-AC Moto-Lift can be plugged into any 110 volt A-C outlet. The motor operates an efficient hydraulic pump to raise the work platform from 7 feet to 17 feet above the floor in 25 seconds. The working capacity is 400 pounds. **Circle E18 on the card.**

GHH Expansion Turbines



View of Expansion Turbine during installation

AXIAL FLOW BLOWERS
GAS CIRCULATORS
COMPRESSORS
EXPANDERS
PRESSURE VESSELS
HEAT EXCHANGERS
COLUMNS

GUTEHOFFNUNGSHÜTTE
STERKRADE AKTIENGESELLSCHAFT · STERKRADE WORKS · GERMANY

REPRESENTATIVES: THE FORAM CORPORATION
15 Moore Street, New York 4, N. Y. • Telephone WHitehall 3-8241

How to strip a storage tank

without scraping or sandblasting

BUT FAST—that's how old coats of paint roll off when you strip tanks the quick, money-saving Oakite way.

Powerful Oakite strippers, applied by hot-flow-on, steam-gun, or cold-flow-on method, actually float off paint, dirt, and grease—right down to the base metal. You save time . . . no hand scraping, chipping or blasting. You save money . . . long-life solution may be reclaimed and reused. And you're safe . . . no fire hazard.

Ask your local Oakite Technical Service Representative for on-the-spot demonstration. Or write Oakite Products, Inc., 50B Rector St., New York 6, N. Y., for details.

FREE Booklet F7629—full of information on maintenance cleaning in all divisions of the Petroleum Industry—describes proved, money-saving Oakite procedures for such jobs as

- cleaning stabilizing towers
- cleaning tank car interiors
- descaling heat exchangers in place
- reconditioning barrels
- salvaging rigs, valves, fittings

Copy sent on request. Write today!

Technical Service Representatives in Principal Cities of U. S. & Canada

OAKITE

TRADE MARK REG. U. S. PAT. OFF.

PETROLEUM SERVICE DIVISION

NO. 2 in a series of ALUMICOAT APPLICATIONS

PROCESS PROTECTS REFINERY EQUIPMENT

More and more refineries are discovering the advantages of the new ALUMICOAT Process! ALUMICOAT offers a firm resistance against corrosive media — *especially sulphur compounds* — and extreme temperatures!

In the ALUMICOAT Process, refinery parts are dipped in molten aluminum to produce a metallurgical iron-aluminum bond at the interface and a surface overlay of pure aluminum. At temperatures exceeding the melting point of aluminum, the aluminum on the surface diffuses. This diffused coating, together with the iron-aluminum bond, provides a refractory material that gives steel maximum protection against high temperature scaling.

The Alumicoat Process can solve your corrosion and oxidation problems. Send for full details today!

ARTHUR TICKLE ENGINEERING WORKS, INC.

26 Delevan Street MAin 5-4200 Brooklyn, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

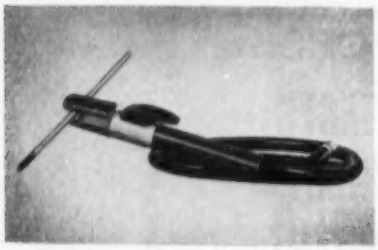
proof handling of corrosive, toxic, explosive, radio-active and other "hard-to-handle" liquids.

The pumping chambers can be piped in series or parallel for compact high head or high volume pumping.

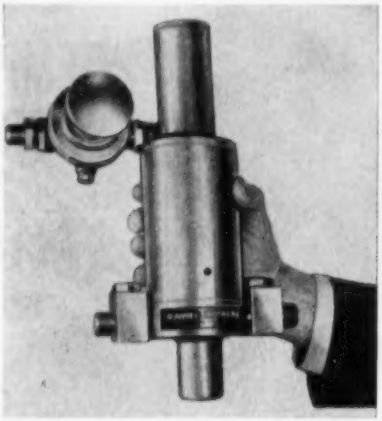
The pump will produce heads to 230 feet. It is available in cast iron, cast steel, 300-series stainless steel, Monel and Carpenter-20. Standard temperature and pressure limits are 450 F and 300 psi, respectively. For information, **circle E19 on the card.**

Cutting Torch . . . A new Arcair cutting and gouging torch, Model G-5, has been announced by ArCair company. This torch has an impact-resistant moulded jaw insulator and a new silicone glass laminate sleeve to protect the upper end of the handle from the heat.

The unit will handle up to ⅜ inch diameter electrodes, and deliver almost twice as much air as the previous models. This cutting torch operates from a DC welding machine and a compressed air line. It has a rotating nozzle that permits changing electrode angle to suit the job, but always maintains air jet in perfect alignment.



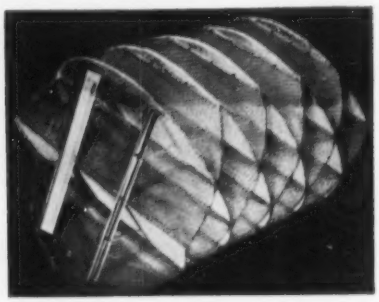
Air and current are brought to the torch through a concentric cable, permitting great flexibility and ease of handling. Depth of cut and amount of metal removed can be closely controlled by the operator. For additional information, **circle E20 on the card.**



Test Pump . . . A new small air driven hydrostatic test pump has been announced by Davies Brothers. The unit was developed to do the work normally done with a manually operated hand pump. It is made in six models with an overall hydraulic pressure range of 100 pounds to 10,000 pounds. There are no metal-to-metal moving parts, and maintenance costs are low.

The pump is governed by Air Reducing and Control valves so that once it has been set to a given test pressure, no further adjustment is necessary.

On a closed circuit, the pump will maintain the pressure for any period of time without air consumption giving the operator freedom to work. The unit is primarily intended for use where small fluid volumes are required such as for testing of valves, and small fittings. It's an economical and compact device and can be used as a source of hydraulic power for small hydraulic mechanisms. **Circle E21 on the card.**



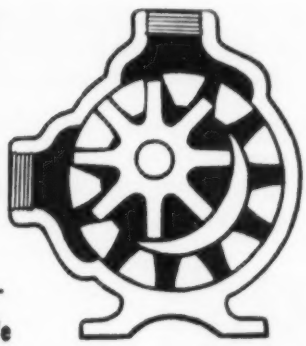
New Tower Packing . . . Spraypak is a material which increases efficiency of absorption, distillation, scrubbing and stripping. Experience in actual installations indicates increases in throughput up to three and one-half times that of exicting bubble tray or ring packed towers. Spraypak is manufactured by S. Blickman, Inc., for Fractionating Towers, Inc. For more data, **circle E22 on the card.**

PRESSURE VESSELS
FOR
PETRO-CHEMICAL PLANTS

You can use the wide experience of St. Mary Iron Works when you build pressure vessels. Our thoroughly experienced staff of designers, engineers and fabricators will furnish the equipment you need. Consult us before you start new construction.

ST. MARY IRON WORKS
Steel Fabricators for Half a Century
FRANKLIN, LOUISIANA

VIKING ROTARY PUMPS



• Cut-Away View Showing Viking's Gear-Within-A-Gear Principle

The unique and unusually simple construction of Viking Pumps . . . with only two moving parts . . . assures you of long, easy-maintenance operation with all grit-free liquids.

Let Southern Engine & Pump Company show you how Viking Pumps can solve your pumping problems. We invite your inquiries.

DISTRIBUTORS
SOUTHERN ENGINE & PUMP COMPANY
MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS
Houston - Dallas - Kilgore - San Antonio - Edinburg
Corpus Christi and Beaumont, Texas.

reach!

A NEW PEAK IN BENDING EFFICIENCY

Pedrick Production Benders offer new standards of efficiency and economy for all pipe, tube and structural bending. Even the most difficult bends can now be made on a production or jobbing basis.

Let us know your problem—and supply a cost-cutting solution.

Write PEDRICK TOOL & MACHINE CO., 3640 N. Lawrence St., Philadelphia 40, Pa. Dept. 13.

FREE "PEDRICK LINE" BULLETIN
WRITE TODAY
SEE PEDRICK BENDERS AT
THE "TOOL SHOW"—BOOTH 356

PEDRICK production benders

Reprints Now Available

1955 PETROCHEMICAL HANDBOOK

Petroleum REFINER's comprehensive up-to-date December Petrochemical Handbook Section, complete with over 70 important commercially-used manufacturing and separation process descriptions and over 70 large easy-to-read FLOW SHEETS (presented in blue-print style).

Plus

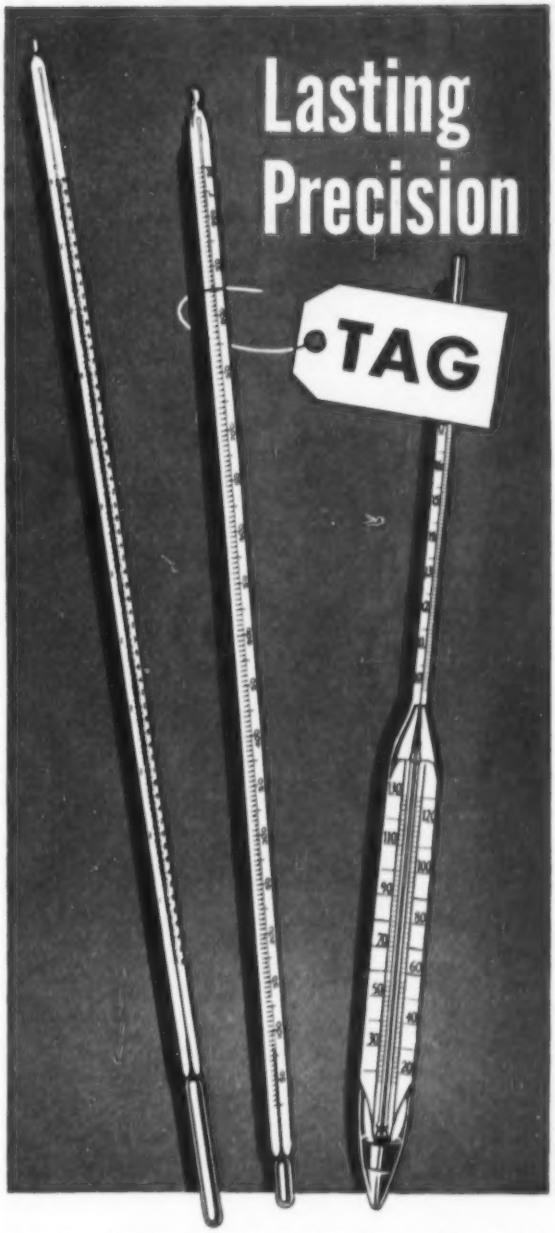
Completely reliable reports on the petrochemical field, particularly its future.

ORDER YOUR EXTRA REPRINTS NOW

$1.00 PER COPY

PETROLEUM REFINER, Reprint Dept.,

P. O. Box 2608 **Houston 1, Texas**



Favorites the world over because of their readability and permanent accuracy TAG etched stem thermometers are available in A.S.T.M., Extreme Precision, and Standard Grades—as well as in Armored Types for special applications. Also A.P.I. Scale A.S.T.M. Hydrometers in plain or combined forms, and a precision grade for general use. Catalog gladly sent on request. WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey... *manufacturers of Weston and TAG Instruments*... a Subsidiary of Daystrom, Incorporated.

WESTON *Instruments*

For more data on advertised products, use Readers' Service Cards, last page.

REFINING BOOKS OF THE PETROLEUM INDUSTRY

To Earn More-Learn More

The knowledge gained through years of work and study by some of the most capable men in the oil industry is set down in the books listed below. Because it is impossible to carry in one's head all the details of his industry, a well-rounded library of reliable data is a definite asset. Not only does it save time, but it often makes his available knowledge of a subject more accurate and up-to-date.

Order some of these books and profit by the experience of others.

ABRAHAM, HERBERT
Asphalts and Allied Substances (2 Vols.) $27.00

ADAMS, ORVILLE
Elements of Diesel Engineering 5.00

ARMISTEAD, GEORGE, JR.
Safety in Petroleum Refining and Related Industries .. 10.00

BADGER & MCCABE
Elements of Chemical Engineering 7.00

BELL, H. S.
American Petroleum Refining 7.50

BENNETT, H.
Chemical Formulary—Vol. 1 thru 9 (each) 7.50
Concise Chemical and Technical Dictionary 10.00

BONDI, A.
The Physical Chemistry of Lubricating Oils 10.00

BROOKS, BENJAMIN T.
The Chemistry of the Non-Benzenoid Hydrocarbons .. 12.00

CAMPBELL & GIBB
Methods of Analysis of Fuels and Oils 4.00

CARLETON, ELLIS
Chemistry of Petroleum Derivatives
Vol. 2 ..... 25.00

CHU, JU CHIN
Distillation Equilibrium Data 7.00

COPENHAVER & BIGELOW
Acetylene and Carbon Monoxide Chemistry 11.00

DIEHL, JOHN C.
Natural Gas Handbook—cloth 6.90
Natural Gas Handbook—leather 8.25

ECKMAN, DONALD P.
Principles of Industrial Process Control 5.00

EGLOFF, HULLA & KOMAREWSKI
Isomerization of Pure Hydrocarbons 7.00

FIESER & FIESER
Organic Chemistry 10.65

GEORGI, CARL W.
Motor Oils and Engine Lubrication 9.50

GILL, THOMAS T.
Air and Gas Compression 4.50
Compression and Natural Gas Alignment Charts 4.50

GRAHAM, FRANK D.
Pumps, Hydraulic and Air Compressors 4.00

GRISWOLD, JOHN
Fuels, Combustion & Furnaces 7.50

GRUSE & STEVENS
Chemical Technology of Petroleum 9.50

HATCH, DR. LEWIS F.
The Chemistry of Petrochemical Reactions 4.50

HESSE & RUSHTON
Process Equipment Design 8.00

JACOBS & SCHEFLAN
Handbook of Solvents ..... $ 8.50

JACOBSON, C. A.
Encyclopedia of Chemical Reactions
Vol. 1 ..... 13.00
Vol. 2 ..... 15.00
Vol. 3 ..... 15.00
Vol. 4 ..... 15.00
Vol. 5 ..... 15.00

KINGSTON, BENSON M.
Acidizing Handbook 3.50

KIRKBRIDE, C. G.
Equilibrium Evaluation Charts 5.00
(20 charts to set)

KIRSCHBAUM, DR. EMIL
Distillation and Rectification 10.00

LOHSE, HENRY WM.
Catalytic Chemistry 8.50

MCADAMS, WM. H.
Heat Transmission 7.50

MANTELL, C. L.
Adsorption 10.00

MELLAN, IBERT
Industrial Solvents 12.00

NELSON, W. L.
Petroleum Refinery Engineering 12.00

RIEGEL, E. RAYMOND
Industrial Chemistry 8.00

ROBINSON & GILLILAND
Elements of Fractional Distillation 7.50

SAGE & LACEY
Volumetric and Phase Behavior of Hydrocarbons 5.00

SCOTT, WILFRED W.
Standard Methods of Chemical Analysis (2 Vols.) 25.00

SHERWOOD, THOS. K.
Absorption & Extraction 8.00

SPELLER, FRANK K.
Corrosion: Causes & Prevention 11.00

STANIAR, WILLIAM
Plant Engineering Handbook 17.00

THOMAS, CHARLES A.
Anhydrous Aluminum Chloride in Organic Chemistry .. 16.50

TREYBAL, ROBERT E.
Liquid Extraction 8.00

TYLER, CHAPLIN
Chemical Engineering Economics 5.00

WARTH, ALBIN H.
The Chemistry and Technology of Waxes 12.00

ZULDEMA, H. H.
Performance of Lubricating Oils 5.00

"Prices subject to change without notice"

Ask for Gulf Publishing Company's FREE "Petroleum Books Catalog," containing detailed information on these and many other petroleum industry books, available through Gulf Publishing Company, Books Department.

THE GULF PUBLISHING COMPANY

P. O. Box 2608 **HOUSTON, TEXAS**

What's New in Manufacturers' Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Thermometers Standards . . . The Scientific Apparatus Makers Association has just released five tentative standards for thermometers. Included are: "Bimetallic, Resistance, Filled Systems, Glass Stem Industrial, and Thermocouple Thermometers.

These standards are adopted in the public interest and are designed to eliminate misunderstanding between manufacturer and purchaser and to assist the purchaser in selecting and obtaining without delay the product for his particular need. For your copy of this useful information, just **circle E23 on the card.**

Isopropyl Ether . . . Carbide and Carbon Chemicals Company has issued a technical bulletin F-40003 covering up-to-date information on physical and physiological properties of this material. Also included are specifications, solubility and shipping data.

Isopropyl ether is an excellent solvent for oils, waxes, and resins. It is a solvent in the manufacture of pharmaceuticals and rubber cements and an extractant for the recovery of phenolics from waste effluents. Isopropyl ether can be used for dewaxing paraffin-base oils.

It is a convenient alkylating agent and a good blending agent for aviation fuels. For your copy of this 8-page bulletin, **circle E24 on the card.**

Electrical Cable . . . Hazard Division of The Okonite Company has just published a 48-page data book on Keystone heat-resistant cables. Typical test results are given for Keystone butyl-rubber insulation under conditions of high heat and extreme moisture. Also included are dimensional tables for power and control cables for direct burial and duct use as well as 24 pages of valuable engineering information helpful in selecting and applying the proper cable to the specific job.

Covered are: Current carrying capacities; Electrical formulas; Horsepower; Full-load currents of motors; d-c conductor resistances; a-c/d-c resistance ratios; voltage drop; induced shield voltage, currents and losses; short circuit currents; methods for determining conduit sizes; maximum pulling tensions; minimum bending radii, and procedure for grounding shielded cable.

For your copy of this useful data book, **just circle E25 on the card.**

Strainers and Air Eliminators . . The Rockwell Manufacturing Company has just published bulletin (OG-326) covering a new line of strainers and air eliminators for use with liquid meters. These units offer "straight-through" flow and increased versatility. For your copy of this bulletin, **just circle E26 on the card.**

Barometric Condensers . . . Schutee and Koerting Company have published Bulletin 5AA, covering its barometric condensers. Included is condenser theory, basic condenser types, applications and construction information and condenser operation. For your copy of this useful and informative bulletin, **just circle E27 on the card.**

Spectrophotometer Survey . . . Beckman Instruments Inc., has just prepared a survey form to estimate spectrophotometer work loads in a laboratory. This new four-page form breaks down into easy to follow steps a laboratory's present and potential spectrochemical analysis work load. By filling in the form, the laboratory director is able to determine whether an automatic recording spectrophotometer will increase production, cut costs, and extend the laboratory's usefulness. For your copy of the form, just **circle E28 on the card.**

Resistance Temperature Detectors . . . Thomas A. Edison, Inc., Instruments division, has just published literature on its line of resistance temperature detectors. This publication number 3016-D is available by **circling E29 on the card.**

PVC Pipe . . . Corning Glass Works has published an illustrated pamphlet giving physical properties uses, specified dimensions and other information on polyvinyl chloride pipe and fittings. Also included are installation instructions. For your copy of bulletin of PE-40, **circle E30 on the card.**

Free to Petroleum Refiner Subscribers

Write for free booklet on preparation of articles for Petroleum Refiner, the technical press generally, as well as papers for technical meetings.

Use Reader's Service blue cards in the back of this issue. Write on the card "Free Author's Booklet," fill in name, address and mail. No charge, no obligation.

Air Dryers . . . The C. M. Kemp Manufacturing Company has announced a new 40 page bulletin, D-100, on the complete line of Kemp Desiccant type Dryers for drying air, gases and liquids. The bulletin explains the 26 principle variables of dryer design and the effects temperature and pressure have on the size of dryer needed for specific applications. Design features and principles of operation are explained, and a complete series of selection charts enables the bulletin reader to select, from the 56 Kemp models, the dryer that will exactly suit his conditions and needs. **Circle E31 on the card.**

Tube Data . . . A new eight-page technical folder on heat exchanger and condenser tubes has been issued by the Tubular Products Division of The Babcock & Wilcox Company. This bulletin, identified as TB-329B, covers pertinent information on all of the various popular grades of carbon, alloy and stainless steel heat exchanger tubing, both seamless and welded. The bulletin also includes a special section dealing with the problems of installing heat exchanger and condenser tubes by the expanding method.

Copies of TB-329B can be obtained free if you will **circle E32 on the card.**

Self-Priming Centrifugal Chemical Pumps . . . The Worthington Corporation has published a new bulletin number W-350-B13 which gives complete information on its Worthite self-priming centrifugal chemical pump. This unit has several unique features such as the priming mechanism, removal recirculation port, and special packing box and mechanical seal features. Included is physical dimensional data and corrosion resistance information on the Worthite alloy. For your copy of this information, **circle E33 on the card.**

Laboratory Appliances . . . The new Fisher Catalog Supplement is just over 100 pages but covers the Fisher Scientific Company line of instruments, apparatus, glassware, laboratory furniture and accessories added to the Fisher stocks since the 1952 publication of the major Fisher catalog. This catalog includes many new developments of particular interest and use in the Petroleum Petrochemical Fields. For your copy, **circle E34 on the card.**

Moisture Measurement . . . A 12-page bulletin has just been released by Pittsburgh Lestrodryer Corporation. Discussed in length are the gravometric, new point and wet and dry bulb methods as well as some less used and even experimental schemes. For your copy, just **circle E35 on the card.**

Advertisers in This Issue

PETROLEUM REFINER, February, 1956

A

*The Air Preheater Corp. 51
Air Reduction Co., Inc. 192
*Airetool Manufacturing Co. 226
Allied Chemical & Dye Corp. 33, 47
*Allis-Chalmers Manufacturing Co. 9, 11
*Alloy Steel Products Co. 197
American Cyanamid Company
Refinery Chemicals Dept. 19
American Machine & Metals, Inc. 176
American Steel & Wire Division
United States Steel Corp. 24
The Annin Co. 79
Armco Steel Corp. 235
Armstrong Machine Works 34

B

*Badger Manufacturing Co. 21
*Bailey Meter Co. 225
Barrett Manufacturing Co. 248c
W. H. & L. D. Betz 83
Bingham Pump Co. 50
*Black, Sivalls & Bryson, Inc. 213
*Blaw-Knox Company 183
*Blaw-Knox Company
Buflovak Equipment Division 18
The Bristol Co. 22, 23
*Brown Fintube Co. 216
*Buell Engineering Co. 84
*Buflovak Equipment Division
Blaw-Knox Co. 18

C

*Calumet & Hecla, Inc. 35, 36
The Cape Asbestos Co., Ltd. 69
*G. O. Carlson, Inc. 16
Carter-Waters Corp. 252c
The Chapman Valve Mfg. Co. 204
Chase Brass & Copper Co. 237
Chemical Construction Corp. 55
Chicago Bridge & Iron Co. 1
*Chiksan Co. 31
*Childers Manufacturing Co. 239
Classified Ads 254
Colton Chemical Co.,
Division Air Reduction Co. 192
Columbia-Geneva Steel Division
United States Steel Corp. 24, 241
Conoflow Corp. 174
Cooper Alloy Corp. 168a
*The Cooper-Bessemer Corp. 209
*Crane Co. 171
*Crane Packing Co. 165
W. H. Curtin & Co. 248a

D

Davey, Paxman & Co., Ltd. 68B
Davis Emergency Equipment Co., Inc. 172
*Dean Hill Pump Co. 61
De Laval Steam Turbine Co. 249
*Delta Engineering Sales Co. 178
Dowell Inc. 88
*Dresser Industries, Inc. 29, 52, 53
E. I. du Pont de Nemours
& Co. 70, 94, 231, 232, 256
*The Duraloy Co. 184

E

*E. C. D., Ltd. 68
The Electric Controller & Mfg. Co. 182
*Elliott Co. 180, 261
Enjay Co., Inc. 179
*Ernst Water Column & Gage Co. 248b
Ethyl Corp. 96, 97

F

Farris Engineering Co. 14, 15
Fielden Instrument Division
Robertshaw-Fulton Controls Co. 224
Fischer & Porter Co. 54
*Fisher Governor Co. 64-65
The Foram Corp. 266
Foster Engineering Co. 199
*Foster Wheeler Corp. 40-41
The Foxboro Co. 26
*Fram Corporation 63

G

Gates Engineering Co. 262
*General American Transportation Corp. 207
General Chemical Division
Allied Chemical & Dye Corp. 47
General Refractories Co. 211
The Girdler Co. 59
Goodall Rubber Co. 220
Graver Tank & Mfg. Co. 275
Gulf Publishing Co. 270
Gunite Concrete & Const. Co. 260b
Gustin-Bacon Mfg. Co. 8
Gutehoffnungshuette 266

*The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1956 Refinery Catalog.

H

*Hammond Iron Works 28
*Harbison-Walker Refractories Co. 62
The Harshaw Chemical Co. 250
*Hayward Tyler & Co., Ltd. 68A
Houdry Process Corp. 25
*Hudson Engineering Corp. 73, 198

I

*Ingersoll-Rand Co. 223
The International Nickel Co. 20, 193

J

Jefferson Chemical Co. 87
*Johns-Manville Co. 263

K

*The M. W. Kellogg Co. 170
The C. M. Kemp Mfg. Co. 32
Kinney Manufacturing Division
The New York Air Brake Co. 251
*Klemp Metal Grating Corp. 265
*Koch Engineering Co. 77
Koppers Co., Inc. 66

L

Laclede-Christy Co.,
Division H. K. Porter Co., Inc. 189
Lawrence Pumps, Inc. 236
Layne and Bowler, Inc. 74
*Warner Lewis Co. 63
Lukens Steel Co. 259
*The Lummus Co. 186

M

*The Mack Iron Works Co. 248c
Manning, Maxwell & Moore, Inc. 253
*Clayton Mark & Co. 238b
The Master Electric Co. 175
Olin Mathieson Chemical Corp. 245
*A. Y. McDonald Mfg. Co. 276
Arthur G. McKee & Co. 58
*The Mercoid Corp. 86
Metal Propellers Ltd. 68Da
Midcontinent Tube Service, Inc. 260c
Millspaugh Ltd. 68c
W. K. Mitchell & Co. 44
*Mixing Equipment Co. 92
*Murray Iron Works Co. 210

N

*National Airoil Burner Co. 196
National Lead Co. 13
National Tube Division
United States Steel Corp. 24
Newport News Shipbuilding & Dry Dock Co. 57
*The New York Air Brake Co. 251
*The Norton Co. 177

O

*Oakite Products, Inc. 267a
*Orbit Valve Co. 85

P

*Panellit, Inc. 264
Tod Pazdral Pipeline Specialties 81
Pedrick Tool & Machine Co. 269a
*Penberthy Injector Co. 181
*Perkin-Elmer Corp. 72
*Petreco Division
Petrolite Corp. 46
*Petro-Chem Development Co. 78
Petroleum Electric Power Assoc. 67
*Petroleum Refiner 246b, 260a
*The Pfaudler Co. 56
Philadelphia Gear Works 6
Pittsburgh Corning Corp. 277
Pittsburgh Lectrodryer Corp. 17
*H. K. Porter Co., Inc. 189, 194
The Wm. Powell Co. 75

R

*The Refinery Catalog 242, 243
*Geo. P. Reintjes Co. 252b
*Revere Copper & Brass Inc. 163
Rheem Manufacturing Co. 27
Rhodia, Inc. 234
The Ridge Tool Co. 222a
Robertshaw-Fulton Controls Co.,
Fielden Instrument Division 224
*Rockwell Manufacturing Co. 71
*Rockwell Spring and Axle Co. 168b
*Rockwood Sprinkler Co. 91, 169
Roots-Connersville Blower Division
Dresser Industries, Inc. 29

S

St. Mary Iron Works 268a
*Sarco Co. 167
*Selas Corporation of America 82
Shand & Jurs Co. 12
Sheffield Steel
Division Armco Steel Corp. 235
*M. B. Skinner Co. 214b
*S. Morgan Smith Co. 252a
Solvay Process Division
Allied Chemical & Dye Corp. 33
Southern Engine & Pump Co. 268b
*Standard Steel Spring Division
Rockwell Spring and Axle Co. 168b
*Struthers Wells Corp. 42
*Sun Shipbuilding & Dry Dock Co. 80

T

Tennessee Corp. 191, 229
Tennessee Coal & Iron Division
United States Steel Corp. 24, 241
*The Terry Steam Turbine Co. 228
The Texas Co. 37
Arthur Tickle Engineering Works 267b
The Timken Roller Bearing Co. 10
Titeflex Inc. 218, 219
*Tretolite Co. 76, 215

U

*Union Asbestos & Rubber Co. 247
Union Wire Rope Corp. 173
United States Gasket Co. 221
United States Gauge Division
American Machine & Metals, Inc. 176
*United States Steel Corp. 24, 241
United States Steel Export Co. 24, 241
United States Steel Supply Division
United States Steel Corp. 24, 241
*Universal Atlas Cement Co. 185
Universal Oil Products Co. 48, 49, 195

V

Virginia Gear & Machine Corp. 6
Visco Products Co. 7
*Henry Vogt Machine Co. 38
*J. H. H. Voss Co. 238a

W

WF Steel Products, Inc. 214a
*W-S Fittings Division
H. K. Porter Co., Inc. 194
Walworth Co. 45
Warren Petroleum Corp. 201
Wedgeplug Valve Co. 43
West Instrument Corp. 246a
Western Supply Co. 190
*Weston Electrical Instrument Corp. 222, 269b
Whitlock Manufacturing Co. 30
*Wolverine Tube Division
Calumet & Hecla, Inc. 35-36
*Worthington Corp. 60

Y

*Yarnall-Waring Co. 2

Z

*Zallea Brothers 39

use these

READERS' SERVICE CARDS

for more information

Here is a quick, convenient way

to get more information on New Equipment and Literature reviewed in the editorial columns and on products and services advertised in this issue of PETROLEUM REFINER:

1. For more data on New Equipment, Catalogs and Literature reviewed in the editorial columns, circle on the card below the Code Number shown in the item itself.
2. For more data on Advertised Products and Services, circle on card the actual page number of the advertisement as listed in the Advertisers' Index on the preceding page.
3. Then, print your name, title, company and complete mailing address and drop the card in the mail. PETROLEUM REFINER's Readers' Service Department will promptly forward your requests to the company concerned. The requested information will then be mailed directly to you.

Quick–Easy

Use these cards to help keep informed on what's new . . . for more job-help information on equipment and services.

Postage Will be Paid by Gulf Publishing Company

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 7 (Sec. 34.9, P. L. & R.), Houston, Texas

PETROLEUM
REFINER

BOX 2608

HOUSTON 1, TEXAS U. S. A.

Circle code number for more data on "New Equipment" editorial items

Circle page number for more information on ADVERTISED products

PETROLEUM REFINER Readers' Service Card — **February, 1956, Issue***

EDITORIAL ITEMS—Circle code numbers on which more information desired:

E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20
E21	E22	E23	E24	E25	E26	E27	E28	E29	E30	E31	E32	E33	E34	E35					

ADVERTISEMENTS—Circle page number of ad for more products information:

1	2	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
84	85	86	87	88	91	92	94	96	97	163	165	167	168a	168b	169	170	171	172	173
174	175	176	177	178	179	180	181	182	183	184	185	186	189	190	191	192	193	194	195
196	197	198	199	201	204	207	209	210	211	213	214a	214b	215	216	218	219	220	221	222a
222b	223	224	225	226	227	228	229	231	232	233	234	235	236	237	238a	238b	239	241	242
243	244a	244b	244c	244d	245	246a	246b	247	248a	248b	248c	248d	249	250	251	252a	252b	252c	253
256	259	260a	260b	260c	261	262	263	264	265	266	267a	267b	268a	268b	269a	269b	270		

Name (Please Print)_____

Company_____ Position_____

Address_____

*FEB. ISSUE CARD EXPIRES APRIL 30, 1956 — Check Square for Extra Card ☐

use these

READERS' SERVICE CARDS

for more information

Here is a quick, convenient way

to get more information on New Equipment and Literature reviewed in the editorial columns and on products and services advertised in this issue of PETROLEUM REFINER:

1. For more data on New Equipment, Catalogs and Literature reviewed in the editorial columns, circle on the card below the Code Number shown in the item itself.
2. For more data on Advertised Products and Services, circle on card the actual page number of the advertisement as listed in the Advertisers' Index on the preceding page.
3. Then, print your name, title, company and complete mailing address and drop the card in the mail. PETROLEUM REFINER's Readers' Service Department will promptly forward your requests to the company concerned. The requested information will then be mailed directly to you.

PETROLEUM REFINER Readers' Service Card — **February, 1956, Issue***

EDITORIAL ITEMS—Circle code numbers on which more information desired:

E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20
E21	E22	E23	E24	E25	E26	E27	E28	E29	E30	E31	E32	E33	E34	E35					

ADVERTISEMENTS—Circle page number of ad for more products information:

1	2	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
84	85	86	87	88	91	92	94	96	97	163	165	167	168a	168b	169	170	171	172	173
174	175	176	177	178	179	180	181	182	183	184	185	186	189	190	191	192	193	194	195
196	197	198	199	201	204	207	209	210	211	213	214a	214b	215	216	218	219	220	221	222a
222b	223	224	225	226	227	228	229	231	232	233	234	235	236	237	238a	238b	239	241	242
243	244a	244b	244c	244d	245	246a	246b	247	248a	248b	248c	248d	249	250	251	252a	252b	252c	253
256	259	260a	260b	260c	261	262	263	264	265	266	267a	267b	268a	268b	269a	269b	270		

Name (Please Print)_____

Company_____ Position_____

Address_____

*FEB. ISSUE CARD EXPIRES APRIL 30, 1956 — Check Square for Extra Card ☐

Circle code number for more data on "New Equipment" editorial items

Circle page number for more information on ADVERTISED products

Postage Will be Paid by Gulf Publishing Company

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 7 (Sec. 34.9, P. L. & R.), Houston, Texas

PETROLEUM
REFINER

BOX 2608

HOUSTON 1, TEXAS U. S. A.

Quick–Easy

Use these cards to help keep informed on what's new . . . for more job-help information on equipment and services.

Setting 'em down easy!

That's a trick requiring plenty of specialized experience. However, this scene at the great Shell Refinery at Houston, Texas, indicates only one facet of the Graver Construction Company.

From design to engineering, to construction and maintenance—Graver is prepared to do the whole job. Extremely flexible in approach, Graver builds not only for the petroleum industry, but for the chemical, steel and other basic industries as well.

Whether it be procurement or construction, setting machinery or plant maintenance, it will pay you to consider Graver—an old name in the petroleum industry . . . a respected name throughout industry.

GRAVER CONSTRUCTION CO., INC.

424 Madison Avenue, New York 17, New York

Chicago • Houston • Tulsa

a subsidiary of

GRAVER TANK & MFG CO. INC.

NATIONAL ROAD CONSTRUCTORS ASSOCIATION

GRAVER . . . *equipped to handle the entire job.*

McDONALD LINE STRAINERS

Advanced design — rugged construction for a full measure of dependability

TOP CLEAN-OUT STRAINERS WITH IRON BODY CAP AND YOKE, AND BRONZE STRAINER UNIT

PLATE 963 — Especially designed for quick, easy cleaning. Yoke is attached and lowered over body during cleaning process to eliminate the possibility of dropping or misplacement.

The strainer unit is bronze with a perforated brass cylinder. Strainer is available in 1/16", 1/8", 3/16" and 1/4" perforations. 1/16", standard for use with gasoline and kerosene, is furnished unless otherwise requested. 1/32" perforations can be furnished on request.

2" and 3" sizes available

PLATE 963-F—Design of strainer eliminates restriction. Identical in construction to Plate 963 except for flanged ends. 3" and 4" sizes available.

Strainer Unit and Top Cap. This type unit used in Plates 963 and 963-F. Furnished with female thread for attaching to male thread of cap, permitting removal of strainer unit from cap during cleaning if so desired.

BOTTOM CLEAN-OUT LINE STRAINERS

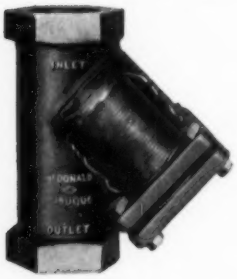


PLATE 914—Bolted Cap Type - cleaned by removing four bolts and lifting off the cap to which the strainer is attached. Furnished with iron body and perforated brass cylinder which acts as strainer. Strainer unit is heavily constructed to eliminate breakage. Perforated brass strainer is available in 1/16" (furnished unless otherwise specified), 1/8", 3/16" and 1/4" perforations.

Sizes 1½", 2", 2½" and 3"

PLATE 914-Y—Similar in construction to Plate 914 except for its cap and yoke design (see illustration). This type is preferred by many from a convenience standpoint. 2" and 3" sizes available

BELL STRAINER

PLATE 907—All bronze strainer used on end of suction when unloading tank cars. The McDonald Bell Strainer prevents sediment from being pumped into tank. Constructed with special rust-proof screen.

Sizes 2", 2½", and 3".

STRAINER CONNECTION

PLATE 806—Used when unloading tank cars from bottom outlet. Strains oil or gasoline before it passes through pump. Strainer is held firmly in place by a guide post on top cap. Removal of top cap removes strainer for cleaning.

Sizes 2", 2½", 3" and 4". Available in black or galvanized.

EST. 1856 McDonald

A. Y. McDONALD MFG. CO.

Dubuque, Iowa